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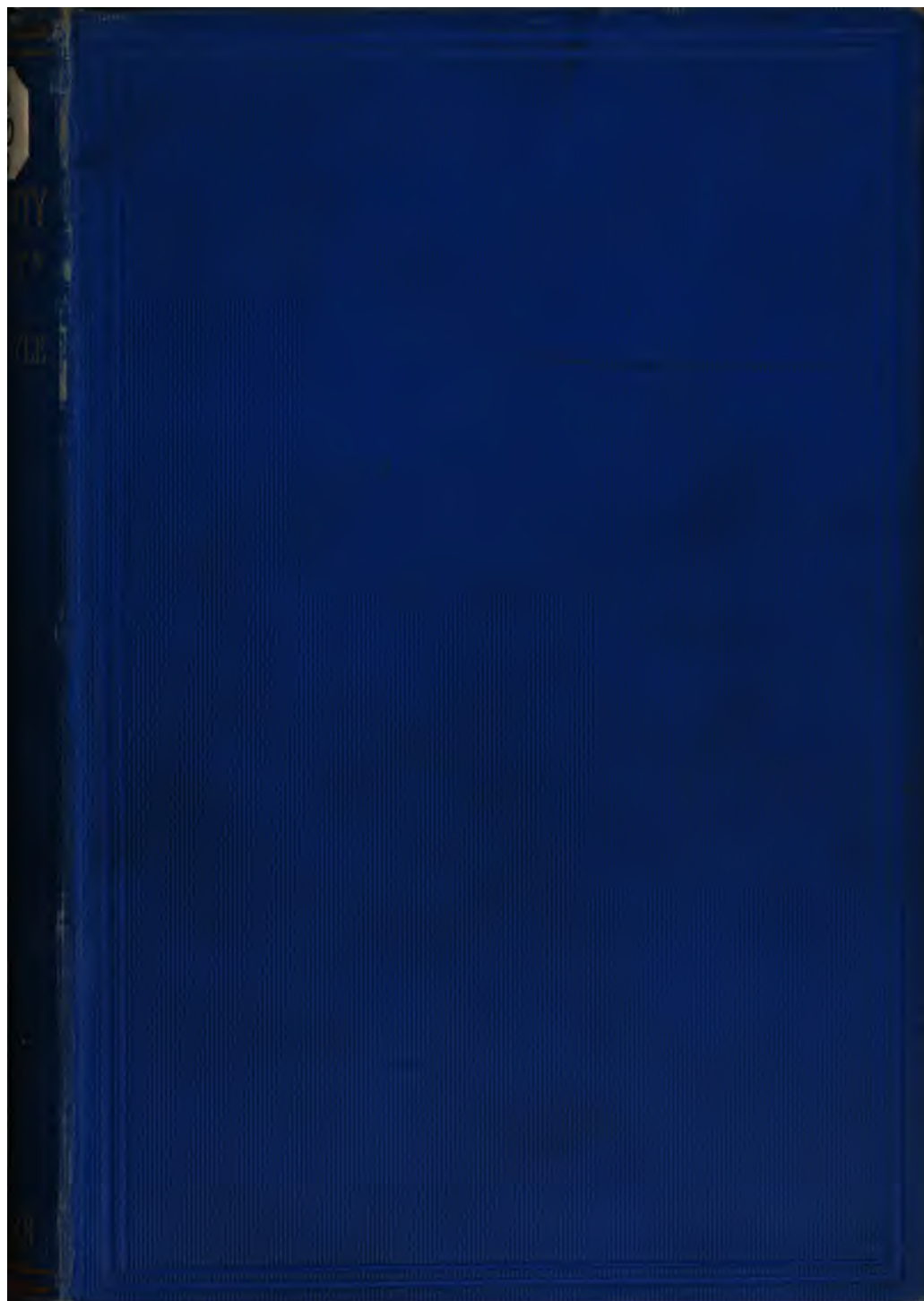
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ELECTRICITY: WHAT IS IT?

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Electricity: What is it?

BY
W. DENHAM VERSCHOYLE, M.E., M.I.M.E., M.A.I.M.E.

WITH ILLUSTRATIONS



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"Effects may sometimes be produced by influences whose action might be unsuspected when the final result comes to be considered."

PREFACE.

SINCE the earliest dawn of history the mind of man has wrestled with the problem of the Universe. Yet notwithstanding these ages of human effort, scarce can we say that a beginning has been made. If we look with pride on the achievements of our day, we must still remember that they had been impossible but for the work of others. We may have proved those others wrong, but still, the seed was sown that in our time has borne fruit. A line that is written to-day, a thought expressed, may contain the germ of truth, the truth that wise men seek, the truth that may blossom into the glorious realization of to-morrow.

In the pages that follow, there may be a line that contains the germ of truth and they are written because—

“The highest truth a wise man sees he will fearlessly utter, knowing that, let what may come of it, he is thus playing his right part in the world, knowing that if he can effect the

change he aims at—well, if not—well also, though not so well.”*

The noble results which Nature has achieved seem to have been attained in all cases by strict adherence to one simple rule, namely, to follow in all cases the line, which of all others, is the simplest. We may then safely accept it as a maxim, that if two or more explanations of any phenomenon present themselves, we are more likely to approach the truth by accepting that explanation which is the simplest and presents the least complications.

If we read the explanations of many of the great Cosmic problems, that were generally accepted, even fifty years ago, and then study the modifications of, or even fundamental divergences from, the old conceptions, which the light of modern research has not alone enabled us to make, but actually compels us to accept; the basic fact that stands out pre-eminently above all others, is, that the general tendency has been towards simplification. Fight that tendency as we may, time and further facts compels us eventually to conform to it.

Our chemists and our physicists keep on discovering new facts and new laws; and the multiplicity and wealth of new discoveries, for which they are responsible, would make it seem a questionable contention that they

* Spencer's First Principles.

tend towards simplification ; but let us widen our vision, let us assemble our main facts in the simplest manner possible, and irresistibly we are led to the conclusion that such is the tendency ; and that assuredly there is one great scheme, and that the simplest of all possible schemes, consistent with the magnitude of the results achieved, which has been followed by the Great Architect in designing the Universe. Not only will all our collated facts find a ready niche therein to receive them, but we are faced with the possibility that our facts are still too few, our knowledge is still too meagre, and our minds are as yet insufficiently developed, to be able to grasp, in its entirety, the simplicity of the laws that govern the interaction of energy and matter.

The tendency of modern thought is to look for a feasible solution of the main problem in the answer to the question.—What is Electricity? Whether this tendency is in the right or the wrong direction, time alone can tell ; but in either case the truth will be arrived at by a process of simplification and co-ordination, which will make all known facts fit into one general scheme which itself will be built upon but a few simple laws. It is entirely possible that these fundamental laws may, at the present time, lie hidden, mainly because of their very simplicity.

In the following pages, generalization, more than the discovery of new facts, has been

aimed at. It may be thought that the generalisation has been carried too far, but on the other hand it may also be argued that such a process can sometimes be of most use when it is carried too far, or at least further, than the facts that are certainly known perhaps warrant.

In any case the value of a thought is not necessarily determined by the construction put upon it by the originator. It is in the minds of others that its most useful application may perhaps be evolved; but to allow of this possibility, it must first be made known, and hence the reason of these pages.

I wish here to express my indebtedness and thanks to Sir William Ramsay, K.C.B., F.C.S., for valuable criticism and suggestions, and for assistance in revising the proofs.

W. DENHAM VERSCHOYLE.

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CHAPTER I

THE GYRON

British Association, Aug. 1907 Meeting (The Times).

Prof. Rutherford. "Positive electricity might be regarded as a kind of cement holding the atom together. The electron was the active constituent in the atom. All attempts to show that the positive electricity was carried in the same way as the negative had failed. *The positive electron could not be said to have been isolated.*"

Sir Oliver Lodge. "With regard to the positive charge there was a difficulty. The positive electron might have no existence, but there *must* be a positive charge."

Sir W. Ramsay. "Hydrogen was an element, but it might be more exact to regard it as an element connected with an electron, and he had a difficulty in disposing of this electron, *when forming a molecule.*"

In view of the above authoritative expressions of modern scientists, may it not be possible that something more than the usually accepted electrical ideas are necessary if we would form a clear idea of the interworkings of matter and energy. The man who is not a scientist has great difficulty in forming any conception of even the forces which his business may place him in daily control of, or association with, and the modern tendency to explain every natural phenomenon as electrical seems but to intensify the difficulty, since electricity itself is unexplained.

Electricity: What is it ?

CHAPTER I.

THE GYRON.

P. I. What is electricity? If we put this question to a modern man of science he will become evasive, and if you press him hard he will probably take refuge in higher mathematics and abstruse generalisations, that will leave the impression on your mind that he does not know. Put the same question to some one who is not a scientist, someone who has just a general knowledge of that specific subject and most others, and you will learn at once that *he* does not know. Alter the question a little, put it in the form—Is there any such thing as electricity? The scientist will at once answer, No—Yes, and the man who has a superficial knowledge of the subject, will say that the question is absurd. He will invite you to come to the nearest electro-generating station; he will point to the electric lamps, to the electric trams, to the telephone, and various other modern appliances, and he will say, “Your question is utterly absurd. It requires no answer, the reply is self-evident.” But if

you say, "I cannot accept the proofs that you have adduced. They convey to me no assurance that there is any such force in nature as electricity. All the appliances and machines that you have pointed to can be operated without any such force. Unless you prove to me that there is such a force, and can show me how it acts, I cannot accept the fact of its existence." He will then murmur, "That it is well known that electricity exists, that it has been known for thousands of years, that all the great scientists of the day admit its existence, and that what is good enough for them is good enough for him."

Now, this is just the point. The man who is not a scientist has a hazy idea that there is a great force in nature, which is known as electricity. He will further tell you that there are two kinds of electricity, positive and negative, and that they are mutually dependent upon, and complementary to one another. Undoubtedly, there exists in his mind the idea that electricity is a distinct entity, capable of producing its effects only when the different kinds are separated, and of doing work only when they are in the act of coming together.

In forming this opinion, he is rightly influenced by the various text books on the subject, which leave no other possible conclusion open to him. He has also undoubtedly, a strong precedent in the authoritative pronouncements of science itself.*

* To obtain a clear view of the relation of electricity to the other forces of nature it is entirely necessary to outline in a

Some of the most recent developments in physics are most difficult to explain, and the difficulties are so great that the acutest brains can evolve a feasible explanation only by keeping an open mind in respect to the question—Is there any such thing as electricity?

The consequence is that in reading a modern work on recent developments, the explanations, whilst ostensibly directed towards the elucidation of the effects they describe, tend on the contrary, to utterly confuse the mind of one who lacks scientific training. The fact is, that whilst there are a great number of effects which have a certain generic relationship, and therefore must logically be assembled under one heading, the eternal effort to make them conform to the old ideas of electricity, tends also to prevent, or at least curtail, mental effort in any other direction. In the general type of facts known as "Electrical," we have a considerable measure of feasible alignment, already thought out and hall-marked by science; and it is less mental effort to think out an explanation that will fit a round fact into a square hole in this scheme than to make an effort to evolve an entirely new scheme into which our new fact might not only fit, just as or more comfortably, but might also in doing so, strengthen the new conception, and possibly lead to a more progressive line of thought, and one

general way a feasible co-ordination of natural phenomena. The reader who is interested in electricity as an abstract science may turn at once to Chapter VI., which in itself explains the view which it is here desired to elaborate.

which might afford a more feasible explanation of cosmic facts in general.

To put the argument another way. Electrical science, as elaborated to-day, represents a beautiful sequence of facts and deductions, the result of years of observation and toil by the acutest and most careful experimentists, mathematicians and theorists of several centuries. It is most natural that those in whose hands lies the future destiny of this science, should strain every nerve to further consolidate its premises and to extend the possible range of its deductions. It is most natural that, as the foundations of the edifice appear to be so strong, that they should endeavour to add story after story to the structure, and that when a new fact is discovered, there is only one question for consideration, whether to use it in further strengthening the superstructure, or in adding height and magnificence to it as a whole. It is perfectly natural that they should not pause to consider that that fact might fit just as neatly into the foundation work of some other structure, which, with the same amount of care and material, might not only attain to the height and magnificence of their own, but might even far transcend it in beauty of conception and in general adaptability to the wants of those that may need to use it.

We might even carry the idea further. Suppose we had an old house, built many centuries ago, according to the very best architectural practice of that day. Suppose that to-day we require to build a new structure, on the same ground, but say ten stories

higher ; to be fitted with electric lifts and telephones, bells and such like innovations, in fact with every convenience consistent with modern requirements. Suppose in this case we consult a first class architect, what might we expect him to say? "We must first examine the foundations and see whether they will bear the additional weight and if not, we must then tear down the old structure, dig up the old foundations, and after digging deeper and studying the conditions below, we will erect new foundations, and upon these we will build the edifice you require. Furthermore, whilst we are at it, we may as well give the foundations a little surplus strength, so that if in the future, additions are required, they may be added without fear of disaster."

Now, we may apply this idea to the modern tendency to incorporate every new discovery into the general superstructure of electrical science. Before building further we should first of all, like the architect, examine the foundations.

If we do look at the foundations, we find as a starting point for our present structure—

Electricity.

Positive Electricity.

Negative Electricity.

Mutual Attraction or Neutralisation of the two.

There are just two ways in which the strength of this foundation can be gauged. We can subject it to analysis in the beginning, or we can load the foundations and test them by raising the structure to its

full contemplated height. If it then falls, we have absolute demonstration that the foundations were too weak.

Now, is not this latter course the actual tendency of modern thought? The question is not—What is Electricity? What is Positive Electricity? What is Negative Electricity? What is the cause of their mutual interaction?—but, shall we keep on building? There seems to be a general consensus of opinion that the wisest course is to keep on building. If a catastrophe happens, well then, probably in the débâcle we shall learn what these things are; and if no débâcle, then will we know that we were right, and shall have proved that there was really no necessity to know or to enquire about these things.

On the other hand it may be claimed that it is only the old language of electricity that is being used, that behind the words “Positive Electricity,” for instance, there is in reality a carefully thought out explanation. That this term, in fact, conveys a distinct idea to the initiated, which it is not thought right to incorporate in elementary text books on this mysterious science. This would mean then that whilst the conception had advanced, there is still so much uncertainty about the advance, that the terminology which was suitable in the days of the two-fluid conception, may for the present be deemed equally adequate. The name is nothing, it is what is behind it that truly matters. But is this so? Is not the mere retention of the old terms an indication of weakness and uncertainty? For instances we have

only to turn to the most recent works—works that have appeared during 1906 and 1907. Take a few terms picked haphazard from over 2000 pages of the most recent thought.

“Electric Fluid,” “Positive Sphere of Electricity,” “Atom Carrying a Negative Charge,” “Atom Carrying a Positive Charge,” “Spherical Atom formed of Concentric Layers of Positive and Negative Electricity,” “Electrified Sphere of Metal,” “Matter is made up of Electricity and nothing but Electricity,” “Electricity is thus merely a form of Ether motion.”

In reading these quotations it can hardly be maintained by any one that they indicate unanimity of thought, or a clear conception of what electricity really is, amongst the leading minds of the world. As each quotation is from a different book, we can see that the writers usually entertain totally different views as to the nature of the entity, upon which rests the whole superstructure of electrical science. The question then obviously arises. Is this a safe foundation whereon to build further additions?

But, it may be said, the want of unanimity is admitted, and it is quite the best thing that could possibly happen that it should exist. We know nothing as to the inner meaning of electricity, and it is only by promoting discussion of different views that we can ever arrive at an understanding. But once this is admitted, an entirely new field is opened up. If there is not sufficient evidence in view to make the entire electrical conception homogeneous and susceptible of absolute definition; then, may it

not be claimed that any other conception, whilst entirely differing in its principles and their application, may be just as much worthy of development ; and that with the same amount of care bestowed upon it, the same amount of calculation and ingenuity displayed in fitting in new facts, there might be just as great possibilities attached to it.

It would seem then that a co-ordination of the facts of the universe, without using the word electricity, might be just as near the truth and just as valuable as the most carefully thought-out scheme that needed it in every sentence.

The final aim of all science is to produce a scheme wherein all facts will have a place, but if in the elaboration of such a scheme, we have in the beginning to make assumptions which we are unable to explain, then it will be entirely logical to broaden these assumptions to such an extent that they will embrace all the facts that need explanation, trusting to time and further facts for future simplification.

In view then of the uncertainty as to the strength of the foundations of electrical science, it is a perfectly reasonable contention that if it is not possible to more clearly define these, then the real question becomes—not—will the electrical theory explain all cosmic facts? but will some other theory explain electricity and all other cosmic facts?

At first sight it may appear that there is but little difference in these two propositions. In reality there is a very great difference.

Electrical science represents the careful assortment

and alignment of a vast number of facts. Like all great schemes, the general arrangement has been arrived at by following but a few general principles. The various branches have been gradually traced up one by one, until finally they all may be said to come together in one expression, the electron, which has been called the unit charge. This unit charge may be considered as determined at a point in the ether, and beyond that point it is impossible to go. We can give that point translative motion, and can thereby explain a great number of effects in a perfectly reasonable and logical manner. We can attach this unit charge to a mass of matter, or an atom or a positive sphere, or anything we please, but that point is still only a charge, a quantity of electricity. By saying then that a portion of matter is charged with electricity, we convey a perfectly lucid idea which we may go on further to develop quantitatively. Electrical definitions and premises can take us no further without considerable alterations, and yet there must be a vast field yet unexplored.

Let us see if it is possible to enter this field.

P. 2. If this unit charge of electricity is capable of any further development, it must be as an ether motion, and if we endeavour to work out that ether motion, it must be from a purely mechanical point of view. We have in fact to stop thinking of it as a unit charge or quantity of electricity. We have got to give it parts, and work out the mechanical effects of the motion of these parts. It is here that the difference in the two statements given above comes

in. It amounts to this. We can account for all electrical facts by supposing that our unit charge is attachable or that it is capable of motion, as a whole, in a straight line or following a curve; but whilst this may be ample for that particular science, there are other forces, such as gravity for instance, which it seems impossible to connect with these premises.

It may seem that but small importance can, by any stretch of imagination, be attached to the parts of a body, which is already small almost beyond the limits of human comprehension; but we must remember that some of the greatest agencies in existence are due to extremely small bodies and their motion, and are appreciable to our sense or our instruments, only when perhaps millions of these bodies are acting in unison.

✓ A milligram of matter is extremely small when any human sense is called upon to perceive it, yet we know that the spectroscope makes no trouble about detecting a millioneth part of that quantity of matter. When we further consider that the electroscope is perhaps a million times still more sensitive, we begin to realise that even the distinctive mechanical effects of the parts of an electron or unit charge might be quite appreciable to some still more sensitive instrument, and that consequently, whilst any effect derived from a single electron would be of little importance, the combined effects of untold millions, all operating in an exactly similar manner, might be productive of great results.

To make an advance in this direction we have then

to strike out, as it were, into a practically unexplored region. We may look on the electron as the last outpost, which connects us with facts, that are more or less certainly located, and that from thereon we are in the region of conjecture.

Now, to form an idea as to the mechanical effects which it is possible to attribute to the parts of an electron, we have first of all to consider the state of motion, which we must ascribe to the portion of ether which is thus known.

Conventionality has almost as strong a hold on the scientific mind as it has on others that are not scientific, so that in the laboratory as elsewhere, ideas and methods that are new are not readily accepted, and it is perhaps well that it should be so. On the other hand it is also true that the imagination of the scientist may often lead him closer to the truth than will the most firmly established existing conventional belief. Many cases might be cited where conventionality and imagination being at variance, the latter had to go to the wall, and usually for a very definite reason. Mathematical treatment of a subject, considered from an imaginative point of view was not possible, because the proper machinery had not been developed. The mathematical machinery was conventional and a discussion of the view which enabled this machinery to be used was consequently often the only one that was attempted. For instance, Newton in his acceptance of the corpuscular theory of light was evidently influenced by the mathematical machinery which he had at his disposal. In other

places he allowed his imagination to assert itself and we then find him giving expression to an opinion which, considering the facts that he then had to work on, was wonderfully close to the most modern view.

In the Principia he says—"And now we might add something concerning a most subtle spirit which pervades and lies hid in all gross bodies, by the force and action of which spirit the particles of bodies attract each other at near distances, and cohere if contiguous, and electric bodies operate at greater distances, as well repelling as attracting neighbouring corpuscles, and light is emitted, reflected, inflected, and heats bodies."

If in this quotation we substitute "ether" for "spirit" we require hardly any other alteration to make it conform to the best modern views, and yet it was at that time an imaginative flight unsupported by experimental proof.

Taking a still more recent case, Professor J. J. Thompson in "The Corpuscular Theory of Matter," (published October, 1907) says—"The corpuscular theory of matter with its assumptions of electrical charges and the forces between them is not nearly so fundamental as the vortex atom theory of matter."

And further on—

"The simplicity of the assumptions of the vortex atom theory are, however, somewhat dearly purchased at the cost of the mathematical difficulties which are met with in its development; and for many purposes a theory whose consequences are easily followed is

preferable to one which is more fundamental but also more unwieldy."

Here again the difficulty of applying mathematical reasoning has evidently had an influence which may be in the right or the wrong direction.

We may gather from the opinions of these eminent scientists that there are two perfectly legitimate ways of looking at the problems of the universe. They are—

- (1) The strictly mathematical view, which evidently cannot be of any use to the man who is unacquainted with the higher branches of mathematical science.
- (2) The purely imaginative view, developed without mathematics.

It appears that the highest authorities are willing to admit that a theory developed in accordance with (2) may be nearer the truth than the other. The man, then, who is not a mathematician need not on that account deplore his inability to attain to a tentative comprehension of Nature's secrets ; he may in fact accept a view now, that in the future may be accepted by the scientists when they have succeeded in overcoming the mathematical difficulties in the way of its present acceptance, and he may thus feel that he knows, despite his inability to follow the more abstruse explanation.

In particular reference to our specific subject—electricity—we may further note the difficulty of eliminating all imaginative effort from even the most

strictly scientific view. Positive and negative electricity and the "occult quality" by which they interact are indefinable, so that it may be fairly claimed that in whatever structure that is raised upon these premises, there is still something wanting; and the field must therefore be considered as open to other theories, but only if they are more fundamental and even if there are mathematical difficulties.

*"To tell us that every species of things is endowed with an occult specific quality by which it acts and produces manifest effects is to tell us nothing. But to derive two or three general principles of motion from phenomena and afterwards to tell us how the properties and actions of all corporeal things follow from these manifest principles would be a very great step in philosophy, though the causes of these principles were not yet discovered."**

In the following pages we shall endeavour to follow out this idea of Newton's.

P. 3. In considering the electron as an ether motion, we must first notice that the electron has no existence until that motion has been established. In other words, the ether continues to be nothing but ether until a certain motion is given to it, and it then becomes an electron. Without the motion it is simply ether, with the motion it is the unit charge of electricity. If the electron is to be used as a basis for the electrical conception, it can only do so after it has become a distinct entity; after it has become in

* Taken from Stallo's "Concepts and Theories of Modern Physics."

fact differentiated from all pre-existing entities and forces by having received a qualification, distinctive of itself alone.

Now, even if we suppose that the existence of the electron is capable of explaining all electrical facts, and that these, more or less, comprise all that is known of the universe, we are still faced with the necessity of admitting some antecedent prime-mover. If we consider all forces and all matter as subservient to the electron, we see at once that every one of these phenomena must be considered purely as ether motions. Energy can only become known to our senses as ether motion. Matter can only become known to our senses as other forms of ether motion. All of the different phases of each, may be referable to the constitutional motion of the electron ; but that, the last and most fundamental, must itself, assuredly be referable to some prime-mover, to which neither our senses nor our instruments will respond.

P. 4. We thus see that it is necessary to admit a prime-mover which we may call Absolute Energy, and also an entity, which is known as Ether, before it is possible for the electron to come into existence.

By a certain interaction, which it is utterly impossible to define, of these two postulates, we have in the ether a certain minute but extremely energetic motion, which is known as the electron. As to the form of this motion we have many opinions, so many indeed, that it is impossible to formulate one that is new and unnecessary even if it were possible, for at present it can be but a matter of opinion.

To pursue this argument any further, it is however necessary to fix on a definite form. In the pages that follow, reasons will be given for ascribing to the atomic and molecular systems a certain form, and it will be seen also that the general contention makes it desirable, if not necessary, to assume a specific form.

We may therefore assume, not because it is the only possibility, but because it is the one that will furnish the greatest symmetry to our scheme, as a whole, that our primitive ether motion is of a vortexial nature. The essential point is that the motion may be considered as a uni-plane motion, but that the plane is gyrating with all degrees of freedom. We have then, as the most primitive interaction between Absolute Energy and the Ether, this gyrostatic motion, which we require to consider as a distinct and separate entity from all other conceptions. We will therefore call it a Gyron. This name is chosen, because it is distinctive and probably new, and not because there is any implied rejection of the electron, or any of the theories in which it holds an honoured place.

It has already been shown that this primitive motion can in no event be considered as a gyron until after the motion has been given to the ether. But now we must go further. The gyron, as an entity, may be representative of two distinct types of motion, which are—

- (1). Its normal or constitutional gyrostatic motion, which may be considered as referable to a fixed point.
- (2). Its translative motion, when subjected to extraneous force, in which case it must be considered as a moving point.

Now, in the full consideration of all electrical phenomena it is impossible to conceive that the constitutional motion of the gyron has any place. Every such phenomenon is reducible to the effect of the moving charge. It is immaterial what the motion may be, so long as it is conceded, that whatever the effect, the unit charge must be in a state of translative motion. Thus, for instance, current electricity is produced by motion in a more or less straight path, whilst static electricity is the result of accelerated motion towards some central point.

As far as we have yet gone in the consideration of the gyron we have no means of producing translative motion, and therefore as yet no connection between it and the electron. If we call the electron the unit charge of electricity, and the latter is in every case the result of translative motion, then the gyron has no relation to the electron until the proper motion has been produced.

We must consequently re-define the electron, or unit charge, as the dynamical effect of the smallest possible moving body. It should be further noted here, that there are other considerations, to be developed presently, which push the electron still further back in the general scheme.

Electricity for our purpose may be classed as a utilitarian conception, which as such occupies a strong and unassailable position. It thus seems to be unnecessary to carry its consideration past the point at which its utilitarianism become apparent, and that is a long way up in the cosmic evolution. It is true, that the same ether motions which constitute electricity, may have a very large place in the building up of the universe, but they are, up to a certain point, merely mechanical effects of the motion of the gyron, and it is only after that point that utilitarian reasons require that certain effects shall be classed under that name.

P. 5. Now we have to consider the possibility of producing translative motion in the gyron. If there is only one gyron in the whole of space, that body, no matter what its constitutional motion, must be considered as in absolute equilibrium.

Within itself it has no quality capable of producing translative motion. No matter what we consider the form of the constitutional motion, and no matter how small or how large, we consider this motion, it must produce in the surrounding ether some form of ether vibration. Furthermore, the energy of this vibration must be exactly equal to the energy of the re-action, on that portion of the moving body which causes it.*

If we first consider the gyron as a disc, rotating at a high velocity, in an ordinary liquid, round its

* Newton's "Third Law of Motion."

geometrical centre and in a fixed plane, we get the idea which it is wished to convey. We see at once that the point of view from which we look at it becomes of very material importance. If we further suppose that the liquid is incompressible, elastic, practically frictionless, and devoid of viscosity, the importance of the point of view still remains, although the effects produced are different. 3

In such a liquid, we get from the edge or periphery of the disc, a simple resolution of the motion of each point on it, whilst from the sides, we should have a more complex motion of helicoidal form. Furthermore, there are distinctive qualities in the resultant motion of the two sides of the disc, and these qualities, as nearly as possible, constitute the two ether motions as complementary to one another. That is to say, that as the speed of rotation increases and the velocity of any point on the surface approaches the limit of possible propagative velocity, the motion generated from say the right side of the gyron, would closely resemble that coming from the left side of a similar contiguous body, if in an identical state of motion considered as to time and space.

The obvious result of this proposition would be, that if two such bodies were so situated, there would be a reduced reactive effect on their contiguous faces. This would be owing to the fact, that the work which both surfaces were trying to do on the ether, had already been done by an external agency; and the consequences of this would be, that the natural equilibrium of both would be upset.

Thus, whilst normally if there was only one gyron in space, the reactions on its surface would be equal and opposite, and it would be in perfect equilibrium, the introduction of a similar body under the stated conditions at any distance would destroy part of that reaction and would consequently upset its equilibrium. Furthermore, as the reaction on the furthest portions of the body would still be operative, the resultant motion of the interacting bodies would be towards one another.

The converse of this proposition would also apply. If one body was turned round, so that the original right side was presented to the right side of the other, a slight dynamical impact would be super-imposed, on the nearly doubled reaction on both surfaces and the bodies would be repelled.

Again, in both cases the degree of similarity, or otherwise, of the induced ether motions, would be independent of the distance in the same way as is a ray of light, and consequently the attraction or repulsion, whichever took place, would be independent of the distance.

If both bodies were fixed in the second position, the repulsion would be continuous. If one or both were free to orientate the plane of their motion, the tendency would be for one or both to seek the position of least resistance to existing forces, and the bodies would thus be again attracted.

We now see that it is possible to produce translative motion in one or both gyrons. If the distance between them was great enough, and they

were both free to move, they would then approach one another at a velocity which would very soon reach the limit, and this would be of the same order as light.

We thus see that the first and most important static effect produced by any gyron upon any other would be attractive, but that under conditions, which possibly do not exist in nature, we might expect a repulsive effect also.

Now, as to the nature of the ether motion thus generated by the gyron, we should expect it to have different characteristics from any other known ether motion. It would be propagated at an immense velocity, probably greater than that of light, since the motion of the gyron must be considered as exceeding in velocity that of any other body. It would be of hellicoidal form, and would therefore be entirely different in its properties to light. On account of its extremely small amplitude, it would pass through all forms of matter, in proportion to the density of that matter.

Consider now a piece of iron weighing exactly one pound. We may suppose it possible to go on subdividing that portion of matter, first by mechanical means, then by chemical, and then by physical processes, until we have broken up the atoms into the minute bodies, which are known as corpuscles or gyrans, beyond which, further sub-division, as far as we know, is not possible. If we broke up all the iron into these small bodies, and were able to keep them all separate and devoid of translative motion, we

should still expect that the process would not rob them of the power of attracting and being attracted to the earth. They would still possess a certain weight, not necessarily one pound in all, but very near it.

We can believe that this weight or power of attracting the earth is then an inherent property of each of these small bodies, whether they are in translative motion or not.

But we only know of one static force generated by the gyron which is capable of producing an attraction, consequently the force described above must be the cause of weight, must in fact be gravity.

Let us now consider the most difficult case, which it is possible to imagine, of the application of this static force of the gryon.

If we suppose three spherical bodies A, B and C, each as large as the earth, to be arranged so that the same straight line passes through their centres, and that the distance between A and B, is any magnitude whatever, and is exactly equal to the distance between B. and C.

We know that in such a case, the gravitational attraction between A and C, would remain practically unaltered, but that the total attraction on A or C, would be very much increased, by the presence of the middle body.

We can follow the action of the gyrons in these bodies best by substituting for the large masses of matter just one gyron at each position, A, B, and C.

Now B, would be in absolute equilibrium, because

a similar negative force is acting, for equal times through the same distance on each side of it. That is to say, on both sides an equal portion of the self-caused reaction on its surface is being destroyed by rapidly alternating impulses. If now we were to displace B ever so slightly towards C, supposing A and C fixed, its temporary equilibrium would be upset and it would start to move towards C. At every point on its course its motion would be retarded by A but to an ever decreasing extent, as the duration of the impulses received from A are decreasing, until C is reached, when the action on A would be the sum of the action of B and C. At any intermediate point in B's course, the action on A would be a couple composed of the pull of both bodies acting as from their mean distance, the time of the impulses coming from B being increased, beyond the normal, by an infinitesimal fraction of a second.

In all cases then of interposition the outside bodies would act upon each other by means of the increased pull of the interposed body.

Whatever pull was thus exercised would be arrived at in an interesting manner. If, as supposed in the beginning, the plane of the gyron was gyrating, with all possible degrees of freedom, at an immense velocity, its ether effects would not be radiated constantly in any one direction. Every gyron on the surface of a concentric ether sphere, would at first receive a repulsive and attractive impulse in every spherical revolution of the gyron. The repulsive influence would tend to induce synchronism of the

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interacting gyrons, and this synchronism would thus become universal. The energy of any gyron, or group of gyrons, would thus be distributed over the surfaces of concentric spheres, and the ultimate effect on any body situated on one of these spheres would thus be inversely as the square of the radius, and since the number of the impulses, whatever their strength, would be proportionate to the number of gyrons synchronised the total influence between two bodies would be $m m' / r^2$.

In the case of transitive interposition, it must be remembered also that as the influence of the gyron is continuously being alternated through space it is not a question of how long an intercepted influence will take to re-establish relations with any distant body by direct propagation, but how long will an already propagated ether motion take to sweep through the necessary angle. The ray of light coming from a revolving light-house, gives the idea, but whilst its revolution is one plane, that from the gyron is in all possible planes.

We thus see that if it was possible to restrict, even temporarily, the gyration of the gyron, and to cause the planes of millions to become parallel, with their centres on the same axis, for even the thousandth part of a second, we should have an increased gravitational effect, very similar to magnetism, which as we shall show presently is caused by this same parallelism of a number of molecular systems.

However, there is at present no means known of creating such a result, which is perhaps well, for if

the gyrational motion is part of the constitutional motion of the gyron, to arrest it for the time named would cause an explosive disintegration of the latter, the effects of which would not be confined to one gyron alone.

The only other static force generated by the gyron is derived from its periphery and is of the same nature as light, its amplitude, however, is very much smaller, but its intensity and velocity considerably greater. It would thus pass through all matter as easily as light can pass through glass. We do not know of it, because there are probably no instruments yet made capable of detecting it; but all the same, it is just as necessary to the universe as light and heat, and its function in Nature will be defined further on.

We may now make a definite statement of the most important conclusion so far arrived at.

Principle I.

The power to attract a similar body is a fundamental property of the gyron and is the principal effect due to its constitutional motion.

We now must consider an effect, which is as important to our planet or any other celestial body as gravity is to the universe. Just as the universe would fall to pieces if gravity suddenly ceased to exist, so would our planet fall to pieces, or at least would suffer very serious deformation, but for this effect. It is this—

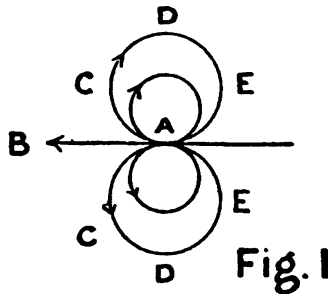
We have seen that we may cause one of our gyrons to move at an enormous velocity. Now, although the mass of this little body is exceedingly small, the energy which it is capable of developing by reason of its velocity is very great. If now we cause a gyron to move, at the utmost speed possible of attainment, along a straight path, its energy of motion causes very serious commotion in the surrounding ether, and owing to the supposed incompressibility and infinite elasticity of this medium the commotion will take a very definite form.

We must look on that portion of the ether, which constitutes the gyron by its motion, as possessing at any instant a definite individuality. It is more energetic than anything else in Nature, even when in a state of static equilibrium. No other force or system or entity in the universe can have any possible destructive effect on a gyron, because if brought into contact with it, or even brought within an effective distance, if disruption of any kind was produced, it would not be the gyron that would be so affected. Whilst itself, it is an effect of an unknown power, towards everything else in the Universe, it is a cause, and the most imperative cause which it is possible for us to imagine. Whether then we consider that at any instant, the ether which by its motion forms the gyron, is the same ether which forms it in the next instant, when the gyron is in translative motion, makes no difference. In other words, it is immaterial whether we consider that it is only the vortex motion that is translated,

as distinct from the vortex motion and that minute volume of ether which received that motion in the first instant of the existence of the gyron.

The fact is, that at every instant of translation a certain definite volume of the ether is in such a state of motion that it is possessed of an unassailable individuality.

The gyron then, may be considered as a minute portion of indeformable material, which is, by reason of the gyration of the plane of its motion of spherical form. In causing such a body to move along a straight path through the ether at a high velocity, we should thus cause perfectly regular and definable external motion to take place. We can best understand the effects by considering the motion in a section plane in which lies the path that is being followed.



Let A (Fig. I) be the gyron which is following the path A B in the direction indicated. In front of the gyron, the tendency is towards compression of the ether, and behind it, towards the creation of a vacuum.

But the ether is admittedly incompressible and it is also infinitely elastic, so that if deformed it immediately returns to its original position as soon as the cause of the deformation is removed. We may say then, that at any instant, a certain volume in space can contain neither more nor less ether than at any other instant. It is thus a physical and also a mechanical impossibility, either to slightly compress the ether or to create in it even a partial vacuum.

The consequence of this is, that the processes in front of and behind our moving gyron must be absolutely complementary, and will thus necessitate the translation of the ether from the point where the compressive tendency is, to the other point where the vacuum creating tendency is. We may roughly represent this ether motion by the circle A C D E, and if we describe any number of these circles passing through A and on both sides of A B, which is a common tangent to them all, we have a representation of what is happening in the ether at any instant in one plane.

Each circle approximately represents the ether motion there taking place, and any point on the curve will receive an impulse in the direction indicated, and the time and distance through which that impulse lasts will be a function of the velocity of the moving body.

If an extraneous point, contiguous to the path A B, was free to move in the direction of any impulse it received, it would do so in the direction of the curve upon which it lay; but if we consider

the general relation of the direction, not in respect to the curve but to the moving body, we see at once that there are three general directions in which the impulse will occur.

- (1) Away from the moving body.
- (2) Parallel but in an opposite direction.
- (3) Towards the moving body.

We may express this in another and more general way. Let us imagine a plane passing through the centre of the moving body, the direction of the plane being such that the direction of the path which is being followed, is always normal or at right angles to that plane. Let us call this plane the Critical Plane of the body. Then we can generalise the above effects in the following way:—

Principle II.

An extraneous point, contiguous to the path of a rapidly moving gyron, is repelled from that body if in front of the critical plane, attracted if behind, and impelled in a parallel but opposite direction, if on that plane.

We have also as a primary corollary of this principle, that:—

Principle III.

If an extraneous point is once upon the critical plane of a moving body, and by altering the path of the moving body is continuously kept there, it experiences neither the repulsion or attraction caused

by the motion of that body as long as that motion is uniform.

We thus see that if a gyron was once induced to assume orbital relations to any other, the velocity might be increased indefinitely without causing disruption of the system from this cause.

If the orbital motion of a body was gradually or suddenly increased, obviously, the body would try to follow a tangent to the curve it had been following up to that instant; but as soon as it entered upon the tangent, the body round which it was revolving would lie behind the critical plane. Under Principle II. it would then be attracted to an extent, which would be proportional to the increased velocity. Conversely, if the orbital motion was gradually or suddenly decreased, the central body would be repelled, as it would then lie in front of the critical plane, and the moving body would be forced into an orbit which the system might not have adequate energy to maintain.

If we consider the forces set up by a moving body, purely as they concern that body itself, we thus see that in every case such forces tend to arrest the motion which causes them.

An interesting point also arises in connection with this effect, which might here be noticed.

If we consider the total ether motion induced about the path of the moving body, we see that it very nearly represents a vortexial tube, closed on itself, and formed about the path of the moving body. As the velocity increases, the sectional area and the

angular velocity of the vortex increase. If now it was attempted to determine the mass of the body, by moving it across another field of force, since the premises could only be based on the interaction of the two fields of force, we see that this method would invariably result in showing that the mass increased with the velocity, especially if compared with a unit, which represented an initial stage of the progression.

Furthermore, since there would be no interaction between the fields where there was no motion, the body would apparently have no mass when stationary. In reality, all that we could prove by such a process would be that if there is no motion no force is generated capable of acting upon the test field employed.

CHAPTER II.

EVOLUTION OF THE ATOM.

The sequence of events that marks the evolution of organic forms is hardly more clearly defined and is infinitely less majestic than that which logically must have preceded it. Inorganic evolution may be accepted, but if it is, the limitations of human knowledge must alone determine the possible range of its conclusions.

CHAPTER II.

EVOLUTION OF THE ATOM.

P. 7 When Kant, Laplace and Herschel laid the foundations of the nebular theory, they went a long way towards providing an explanation of many of the astronomical wonders which we see around us. Whilst there are many who object to this theory as an explanation of the evolution of a planetary system, such as our own ; the arguments which this theory provides in favour of such an evolutionary process are most seductive. Since the time of Kant, much work has been done, and many discoveries made, which have alone been possible by reason of the improvements in optical instruments, and the development of photographic science.

At the present day there are somewhere about 120,000 nebulae known, and about half of these have been determined, either by direct observation or by photographic methods, to be of spiral form. According to the nebular theory, these great spirals are worlds in process of formation. A widely diffused, amorphous nebula, such as that in Orion, which is one of the best known, may be looked upon as one of

the primary steps in the evolution. After untold ages of existence in this state, the spiral form is gradually assumed, which passes by slow degrees into that of concentric rings. These again by rupture, and concentration upon themselves, give us a planetary system similar to our own.

It should not be forgotten that in the meteoric hypothesis many eminent physicists now see a better explanation of the formation of the solar system than in the nebular. It would seem, however, that the meteoric hypothesis has no standing at all unless it is based on the other. Cosmic dust or meteorites are complex atomic and molecular aggregates which cannot have come into existence as such. It is necessary to postulate some form of nebula to explain fully the existence of a meteor, and an hypothesis based entirely on the latter can thus hardly be claimed to fully explain the evolution of the universe.

5 Each of these steps from the primary fire-mist to the solid planet, must each have required a vast expenditure of time, and a great dissipation of energy. As the components of the spiral draw in from a state of gaseous dispersion to one of primitive solidarity, they lose a part of the potential energy with which they were originally invested, and assume more and more complex relations to one another. The spectro-scope certifies that within the sun there are close upon forty of the known terrestrial elements; so that in comparison with other stars, which have been investigated, the sun may be considered as a body in

which evolution has already made great progress. On the other hand, the same instrument discloses the fact that in the most primitive stars or nebulae known, there still are at least two or three of these earth-elements discernible. This remarkable fact teaches us at once that the history of a planet does not necessarily start with the nebula that is capable of effecting the photographic plate. In the elements H, He and Ast, which are usually discernible in the most elementary star forms, we have evidence of long ages of antecedent evolution. If it is possible to trace the evolution of nearly all terrestrial elements, from hydrogen upwards, in stars that are approaching the temperature of the earth; it is then also possible to imagine, that in other invisible bodies, the stage of complexity illustrated in the hydrogen atom has not yet been reached. Furthermore, it is quite conceivable that the evolutionary period through which, for instance, a sun-hydrogen atom has gone to reach that stage, may be infinitely greater than that which has elapsed since it came into existence.

If then we wish to gain a comprehensive knowledge of the evolution of say a copper atom, we require to look to the time that preceded that stage at which it became visible as such, to even the spectroscope. The copper atom, as we know it now on earth, is representative of but one stage in its existence, and whatever construction we assign to it, by whatever means we suppose it to have attained and still retain its individuality, whatever traits connect it to and also differentiate it from all other types,

these must be the results of whatever previous evolutionary process it has gone through.

It will be futile to imagine an atomic constitution that will with difficulty conform to the requirements of our day alone. When we consider that the time, during which conditions have been, and will be suitable for these atoms to enter into chemical combination with each other, must be very limited as compared with that which has been necessary for their evolution, and that which will be necessary for their devolution, the futility becomes apparent.

Suppose that we find evidence that in a star like Alpha-Cygni, copper is undergoing devolution, that in fact there is good reason to think that it will shortly cease to exist in that star. If again we find that in other types of star, as in Algol or Markab, there are evidences that the copper atom is just coming into existence. If, moreover, there is good reason for supposing that both these types have passed through a stage, which is exemplified in Lockyer's Argonian group, in which the only elements that can be proved to exist are hydrogen, helium, and astertium; it is then entirely necessary, that in framing a conception of the copper atom, we should endeavour to constitute it so, that it will not only fulfil the requirements of the modern chemist and metallurgist, but that it will also fit into the not unreasonable theories of its evolution and its devolution.

The copper or any other atom is, and can be, but a mere incident in the history of the universe. It is entirely a product of circumstances, which it does not

make, but conforms to. As the conditions to which its constituents were subjected, permitted it, this and all other atoms were formed; and we cannot but believe that the evolution was continuous, step by step, from the most elementary types right up to the most complex.

As to what was the governing principle in determining this evolution, there can have been but one possibility. If we have evidence of evolution, such evidence makes primary dispersion a necessity. The parts may only evolve the whole by coming together subject to compulsion. If then we have dispersion and a tendency to come together, we have in the parts a fund of potential energy, which on being wholly or partially dissipated, forms the whole; and the measure of complexity which becomes evident in the whole, is an exact representation of the amount of potential energy which has been changed into some other form. The initial energy of the parts has thus been the governing principle in the primary evolution. Temperature can be but a result of the dissipation. A high temperature shows that dissipation is taking place rapidly, and that the parts are tending towards complexity. An ether vibration, of the form of a heat wave, can only exist if it has been caused by some body in violent motion—if there was no body and no motion, there would be no such ether vibration. Consequently then, before any celestial body can emit a light or heat wave that is effective on this earth, it must have already gone through long ages of evolution, and this primary evolution must

have been managed without the interference of energy in any such form. To bring up our parts from a state of infinite dispersion to one of primary aggregation, electricity is in a similar position, it cannot help us ; or if we complicate matters so as to allow of its being operative, further evolutionary processes become if not impossible, at least so intricate that they lose all semblance of reality.

To make any progress then in forming an idea of the constitution of the atom we must leave out of consideration, for the present, its laboratory requirements. We must go back millions of years—we cannot even stop at the Argonian stars, or even at the most primitive known forms of nebulae. We must look on these as products of infinite aeons of progress, and must look for the beginning of things in a state of absolute dispersion. By this is meant a state wherein a group of even two electrons or gyrons is unknown, and can only be attained after perhaps ages of dissipation.

If we suppose that the first interaction of Absolute Energy and the Ether, caused the formation of a vast number of gyrons throughout space, and that each one was situated at any distance we please—a mile or a thousand miles—from its nearest fellow-gyron, we have the idea.

If a state of gaseous dispersion, as in the Nebulae, is a reasonable conception, and that subsequent atomic types have been the result of evolution from this stage, so also is it an entirely reasonable supposition that even this stage itself is the result of concentration

from an antecedent stage of even more complete dispersion. It is not consistent with any exhaustive scheme of evolution that any organism, no matter how lowly, should have primarily existed as such. If there is organization at all, the system must be susceptible of simplification—it must be reducible to a state, where there is no organization. In the case of the most simple atom or proto-atom, this can only mean the dispersion of the parts. If then the parts or individual gyrons which compose the most primitive atom, must have been first existing in a state of dispersion, and we wish to start at this point and to assemble them into systems or groups of atomic dimensions, which are inter-related to one another, it would appear that we must require a most complicated set of laws to govern the operation. In reality however this is not so—in fact it becomes a question not of adding but of eliminating—of simplification and not of complication. We may reduce our conception to the last stage of simplification, which it is at present possible to imagine, and then feel sure that we have not gone far enough; for in every natural operation, of which even a partial understanding has been arrived at, such is unquestionably the tendency.

We may then start upon the evolution of the atom at the point where we have infinite dispersion of its parts. We shall then be untrammelled by any consideration of the effects of heat, light, or electricity, because these did not exist at the time, and we have absolute freedom as to time and space.

We have then, as a basis to work upon, the gyron,

the smallest material body possessing real individuality. It is, in itself, capable of attracting and being attracted by any similar body, and it is further capable of developing an immense energy as the result of its translative motion. We have also developed three simple principles, to help us in the elaboration of our scheme. Given now, untold millions of these little bodies, suddenly created throughout space, we should have all the material required in the evolution of our cosmos.

The general trend of our argument will now be to show that by a purely mechanical application of a few simple principles it is possible to trace the evolution of the simple molecule through the different phases of—first, the single gyron; second, the primitive atom or group; third, the elemental atom; and fourth, the simple molecule.

It is proposed to adduce evidence from the numerical relations of the atoms, when arranged according to their distinctive attributes, that a planetary construction will explain these relations, and in so doing tend to support the general contention.

We may here state, in connection with this planetary construction, that just as the bodies, comprising a celestial system have an eternal tendency to take up a position in one plane, so have the bodies comprising an atomic system. The relation may be disturbed by external causes, and the bodies may depart from this principal plane, but give them time to dispose of their surplus energy and they must inevitably come back to it.

We have, as yet, no other static force than the two which each gyron, by its own constitutional motion, is able to generate.

We have as the most important of these two forces, the one that must at once be effective if brought to bear on any other gyron, that must from its nature be the principal controlling force of the universe, what we may call the Alpha-force, generated by the lateral surfaces of the gyron.

We have, as the sole other static force, what we may call the Beta-force, generated by the periphery of the gyron.

We have also, as a possibility, contingent upon motion, the Gamma-force, generated about the path of a moving gyron.

Given then, these millions of gyrons distributed throughout space in a purely chaotic condition, no qualifications as to distance, except that they shall be without order, and no forces existing or operative, except the Alpha-and Beta-force of each body. What will be the next move? Clearly, hardly any one body in the whole vast host will be in a state of equilibrium, and each one will consequently start to move in the direction of greatest compulsion, and to generate on its own account the Gamma-force; which must be considered as secondary in importance to the Alpha-force, only because it is an effect of the latter. If the distances are great enough, it will soon leave its parent behind in relative importance and will, where possible, take affairs into its own hands.

The intense motion, which must instantly result

will be influenced by Principle II. Every gyron will be attracted towards some other by the action of the Alpha-forces, but whilst the energy is so great, they will never come into actual collision. The force generated by their motion can be operative, only when the distance between them is comparatively small, but as they keep on approaching one another, their kinetic repulsion, due to Principle II, will greatly transcend their static attraction, and they will consequently be deflected into new paths. The consequences of this elementary process will however be that they and millions of others, undergoing the same operation, will lose energy ; and the final result will be the formation throughout space of great centres of attraction, towards which all the gyrons within the influence will gradually begin to work.

There were thousands of these great attractive centres formed in different parts of space, at various distances apart, each one of which went through the same processes as time went on. Our business is however to try and follow the events happening about one centre.

The process of centralization must go on continuously, until at last the gyrons, within the influence of one of these great centres, have lost a considerable portion of their initial energy.

After perhaps millions of years a stage was reached at last when two gyrons on approaching one another felt the effects of Principle II to such an extent, that after their critical planes had for an instant coincided,

the subsequent Gamma attraction was sufficient to force them into orbital relations.

They then revolved round their common centre of gravity, in a similar manner to what is known as a binary star, thus forming the most elementary of all groups from which all others have descended.

The same operation would be going on, about the same time, in millions of other places that lay within the radius of the influence of our particular great centre. We have therefore a new influence to consider, namely that of one binary group upon another.

P. 8. First of all we must make a slight retrogression and see what has really happened up to this point. As soon as our great centre of attraction has been established, each of the gyrons within its influence has acquired a new property. It has acquired a new fund of energy of the kind which is known as "Potential" energy. At the moment that it was first created it possessed potential energy by reason of its distance from the nearest gyron. But the fund which it then had at its disposal is insignificant when compared with that which it now has by reason of its distance from its great centre.

This centre may be 1,000,000,000 miles away, or double or treble this amount, and our gyron should thus be able to do an immense amount of work in passing over this distance. If however the gyron was left to itself it would proceed to exchange its vast, resources into the more negotiable commodity known as "Kinetic" energy or the energy of motion. It would fritter its whole wealth away in a few days,

and would arrive at the centre devoid of potential energy. It is however prevented from pursuing this course by the intervening gyrons and Principle II, and they so hinder it in its dissipative progress that instead of taking a few days it will take untold millions of years; and although the other gyrons have all the same tendency towards dissipation they mutually arrest and compel one another to stop and use up some of their energy in doing useful work.

Now at the instant that the components of our binary groups decide on their partners, they have each a fund of potential energy with respect to that partner. They get rid of a great part of this in coming down to a really stable binary relationship; and they then keep on dissipating the balance as they whirl round their common centre of gravity.

The dissipation now takes a useful form. They set up between them, as a system, influences in the ether which are in every way analogous to the Alpha-and Beta-forces of the gyron. Just as in the case if the gyron, if two binary groups should approach one another, with the wrong side foremost, the plane of both orbits would be orientated until the position of least resistance was reached, and they would then be attracted to one another, definitely and strongly.

Each of these binary systems then might be considered as a single gyron, they would act the same and would develop Alpha-and Beta-forces, similar as to form and action, but of greater amplitude and inferior intensity. They would thus be less penetrat-

ing and consequently effective over very much shorter distances.

P. 9. At this point a new and important effect comes into operation, which may be described as the most elementary form of chemical "Selective Affinity." As this effect is very important in future building operations, we shall have to reduce it to the form of a simple principle to facilitate future reference to it.

It must be remembered that each step in the evolutionary process, here outlined, requires an enormous expenditure of time. We are at present mostly concerned with the evolution of certain groups, but we may so far anticipate a future chapter to say here, that the time of dissipation of energy which was necessary to produce any of these groups, is not entirely dependent on the total original energy of the components of that group; but is related first to this energy and secondly to the total energy of the universe. It is thus plain that the evolution of so simple a combination as a binary group is a matter, not of days or years, but of millions of years. This consideration also demands that from the time a binary group is formed, until the time when all the potential energy of its components has been frittered away, must also be a very lengthy period; and furthermore, that as the elements of the binary groups, that from time to time come into existence, keep on growing in magnitude, the time of total dissipation will become very much extended.

We thus have two forms of selective power to consider—

- (1) That between entirely different groups when they are at about the same stage of dissipation.
- (2) That of the same group at different stages of dissipation.

We have traced our evolutionary process to the point at which there are an immense number of similar binary groups in existence. But it is still necessary to believe that there are a vast number of free gyrons, which have not entered into this relationship, and that consequently, in its wanderings, a binary group is liable to encounter, not only its own kind, but also others that lack its specific development.

Now, the only form of static attraction which we have so far supposed to exist, and the only one which it is still necessary for us to suppose, is based on the following self-evident truths or axioms—

- Ax. 1. A rotating body causes motion in the surrounding ether.
- Ax. 2. A reactive pressure is produced on that portion of the surface of a body which is responsible for any external ether motion.
- Ax. 3. If the ether motion which any surface of a body is capable of producing by its motion, has already been produced by an independent agency, then there will be no reaction on that surface.

It is clear then that the more nearly the independently induced ether motion coincides with

that which would have been produced by the surface of a body, the less reaction there would be on that portion of the surface exposed to the influence, and the greater would be the attraction towards the source of the independent motion.

Conversely, if the independent motion had only a very slight resemblance to that which the surface would have generated, the reaction would be influenced but little, the equilibrium of the system as a whole will be but little effected ; and a very feeble, if any, attraction will result. In the case of any uniplane body, such as the gyron, the more nearly the independent motion coincides with the motion of one side of the body, the more strenuously will it oppose the motion of the other side, thereby producing repulsion and generally instantaneous orientation of the plane of that body.

If these considerations are applicable to the gyron, they must also be applicable to all bodies or systems having a similar general form and order of motion.

Since the induced ether motion must be dependent on the constitutional motion of the body or system, we may say generally, that—

Principle IV.

The intensity of the purely static influences, existing between any two systems, is directly proportional to the synchronism of their constitutional motions.

This principle would obviously apply most rigorously to the systems that had arrived at such a

state of equilibrium, that the components were sufficiently close and uniform in their effort to cause an ether motion, which was representative, not of the components severally, but of the system as a whole.

If we think of any group as having been in existence for say a million years, and suppose that during that time the conditions about the great centre, to which it belonged, had always been favourable for its development, then we should find that at any definite subsequent epoch the group would be existing in various stages of dissipative constitutional motion. In other words, a binary group which came into existence to-day would have a very different amount of internal energy to one that had already existed for one million years; and the two would have as a consequence, very different powers of influencing other similar or dissimilar groups.

There would thus be distinctive stages in the career of every group, at which it would be better fitted than at any other, for entering into relation with different pre-existing types.

P. 10. We must not however overlook the possible influence of the Gamma-force, generated by the intense orbital motion of the components of any large system.

Supposing that a small and somewhat old and inactive system A, has been sufficiently attracted by a very active system B, to assume a parallel disposition of its plane, with the centres as close as possible, then the superior motion of the more active system would undoubtedly have an influence on the motion of the other. Furthermore, there would be a mutual

effect. The tendency would be, as much as possible, to level up the difference in the energy of the two systems; with the result that eventually the attraction of A for B might be greater than A for any other A, or B for any other B.

P. II. We are now prepared to follow out the fortunes of our first primitive gyron group. There is no doubt that, according to Principle IV, the attraction of a binary group for any similar system that it approached, would be greater than for one of its own components, singly. This would specially apply in the first stages of its career, but as they continue to lose energy they would eventually get down to a stage at which they would have practically no orbital velocity at all. They would lose their analogy to the binary star, and in this state as a system, they would almost cease to generate any Alpha-force and would thus have little attractive force beyond that due to the constitutional motion of the component gyrons. They would then form what we might call a static group, the principal members having lost nearly all their kinetic energy.

But even in this state they are not without a place in the evolutionary scheme. They can still hold in orbital motion, a body which has not too much mass and velocity. They can still form the basis for the second type of primitive group. They can form a centre for a new system, whose centre of gravity corresponds with their own centre, instead of being midway between the components, as in the binary system.

As time rolls on and more energy is dissipated, this second type would assume the most important place in the evolution. More and more groups would be reduced to the static state, and these would find plenty of small bodies which were only too willing to be held in subjection. This new type would be, like the first, subject to Principle IV, and would thus have a "Selective Affinity" for its own kind.

P. 12. But time must still go on, more energy must be dissipated, more groups come together. The whirling vortex about the great centre is drawing them all towards it, and they are losing their potential energy and coming closer together. Events of astronomical importance may have also happened by this time. New centres have formed themselves subsidiary to the great central vortex and whirling round it in vast orbits. We will suppose our groups now to owe allegiance to a subsidiary centre, itself bound to the great central vortex by laws that are simply extensions of those that govern the smallest groups.

Time still goes on and the evolutionary process with it, as if nothing had happened. Energy is lost and new groups are formed. It is nothing to them that worlds are in process of formation all round them. They have now a new centre to aim at, and their business is to get there as quickly as possible. But the same difficulty is experienced, the same principles are operative, and they must go on, just as they have begun, only their apparent rate of progress must now be much greater.

P. 13. Through all this mighty evolution of order from chaos our simple primitive groups have not been idle. As the conditions of their energy allowed them, they have added new terms to a progression, and the determination of the numerical relations of these terms is so simple that it would present no difficulty to a child who had mastered the most elementary mathematical processes.

The two most primitive types have simply gone on doubling.

In this process naturally the binary type has been in the lead, and as each new term was added to its progression it became possible to add another term to the other.

As time went on the process became a little more complex, but was still simple enough to be subject to the same principles, and to the considerations outlined in former pages. If we call each of the terms in the binary progression an epoch, then we may say that as each epoch was reached, the time during which the conditions were suitable for its formation increased, also as each epoch was reached the kinetic energy of the components decreased, owing mainly to the fact that they had not sufficient room to gain the same orders of velocity.

We have then a growing tendency on the part of the epochs to form static aggregates. That is to say, that instead of arranging themselves in an orbit described round a common centre of gravity, they now become subject to Principle IV almost entirely. Furthermore, as there may have been thousands of

years between the appearances of different members the same epoch, we should have these members in various stages of dissipation towards the end of any epochial time. In accordance with Principle IV we should then find aggregates of two or more synchronic members, and as the size of the epochs grew, the number of these synchronic groups would also increase.

Also since the static attraction of such an aggregate for pre-existing groups, would depend not only on Principle I, but also on Principle IV, we should have aggregates of each epoch, having very different attractive capacities.

To make this process more clear, suppose we take the fifth term in a geometrical progression whose first term is 2 and whose common ratio is also 2. We have then the number 16, which is composed of two eight groups in binary motion. Now at the time that this 16 group was formed, there were very few other groups in existence that were not either 16 or 8; so that even supposing that it was capable of existing in very different grades of motion, it would have but very little choice of partners. It must very soon have either entered into partnership with another 16, to form the next term in the binary progression, or with an 8 to form a term in the other simple progression, which was going on at the same time.

If now we follow the binary progression through several terms we see that all the time the component groups are growing in mass and losing velocity.

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They cannot then fritter away their energy at the same relative rate as the primitive types, they have greater permanency as types, less inclination to exist as binary groups, and more inclination to form aggregates of the synchronic members.

Following is the progression which illustrates the growth of the two main types, from a single gyron to the sulphur atom—

TERM	BINARY PROGRESSION	PLANETARY PROGRESSION
1	1 gyron	—
2	2	3
3	4	6
4	8	12
5	16	24
6	32	48
7	64	96
8	128	192
1	256	384
2	512	768
3	1024 H	1536
4	2048 A n	3072 3
5	4096 H e	6144 6
6	8192 B e	12,288 C
7	16,384 O	
8	32,768 S	

To illustrate further let us take the fifteenth term in the progression, which consists of 16,384 gyrons made up of two groups of 8,192 each. Now whilst the form of this group may be identical with the fifth group mentioned above, the conditions of the distribution of its internal energy are quite different. These conditions are such that it is able, under Principle IV, to exercise a very different influence on pre-existing bodies; and it is further able to from

static groups of its own synchronic types which also have strong individuality.

To express this in the language of chemical science, we might say that each epoch, as it was formed, had a growing tendency to form, first, isologous, and secondly, homologous series. Both the size of the components of the epoch and that of the pre-existing primitive dissimilar types would tend to increase the possible stable terms in such series.

P. 14. Now, if we return to the great evolutionary process outlined in paragraph 12, we see that a new centre has been formed subsidiary to the great central vortex. We may suppose that this new centre is 93,000,000 miles from the great central vortex, and that it is our own planet in embryo. During the long ages that follow, the eternal tendency of all the gyrons, that belong to this new centre, is towards consolidation.

They are all striving to get towards this centre and to diminish their own potential energy with respect to it. Incidentally, they are using up the potential energy which each possesses with reference to the nearest gyron or group. Soon it becomes a question, not of single gyrons or simple groups, but of large groups, formed subject to our four simple principles, having relations one to another, as the terms of the most simple geometrical progression that it is possible to imagine.

The ages roll on, consolidation progresses, and at last, out of this orderly chaos emerges a progressional term, which if we had been on another planet at the

time, and had had at our disposal a spectroscope of sufficient refinement, we should have been able to recognise as the first phase of the most simple element that our senses are able to perceive. We should, if we had had proper standards to compare it with, be able to determine it as proto-hydrogen, representing the 9th or the 10th term in our binary progression and consisting of either 256 or 512 gyrons.

If the term of our life could then have been extended, much beyond the ordinary limit usually allowed to mankind, we should have been able to follow our progression, term by term, through hydrogen and subsequent types.

P. 15. Now, one of the greatest advances of our time has been the determination, by experiments of the utmost refinement, of the approximate number of gyrons that go to make up the hydrogen atom. If we, as a result of these researches, were able to state definitely the exact number of gyrons, we should be able to say which term of the progression was hydrogen. In reality, however, this is impossible at present. Different scientists arrive at results which, whilst firmly establishing the order of magnitude of the number, can hardly be said to place that magnitude within finer limits, than one or even two hundred one way or the other. If we take about the average of the results obtained, we should have somewhere about 800 gyrons as a close approximation to the number of the gyrons in the hydrogen atom.

Now in our binary progression we have, lying on

either side of this number, the 10th and 11th terms consisting of 512 and 1024 respectively.

If we take the closest numbers in the planetary progression we have the 9th and 10th terms, consisting of 768 and 1536. If we eliminate the extremes, we have the 10th term in the first, 1024, and the 9th term in the second, 768, to choose from. However, it is immaterial which term we use as the unit.

We know that all atomic numerical relations are expressed in terms of this unit. Whatever term in the progression we take then, we may call it the unit and express its value by the number, 1. Thereafter, if we find that an atom weighs, say 127, we know that means 127 times the unit. If we want to know the number of gyrons in that atom, we should then have to take 127 times the number contained in whatever unit we take.

By this means we may deal with simple numbers, which need not exceed 240, to express the whole range of elemental atoms that we know. The simplicity of our subsequent progression makes it then quite immaterial which term we use as the unit.

We have now arrived at a point, from which on, it is not necessary to rely on theory alone. If our simple progression has taken us as far as the unit term in our known atomic progression, and we have theoretical considerations, on the one hand, that would carry us further along the theoretical line, and on the other hand, practical considerations to show us what actually is; then it only remains to indicate broadly what the former would lead us to expect and

to compare this with what we actually know to be the case.

First of all then we should expect to find a backbone, as it were, running through the series of the terrestrial elements, consisting of the most recent epochs, which are simply the numbers—

1, 2, 4, 8, 16, 32.

These numbers meaning simply multiples of our unit.

It should here be pointed out, however, that whilst these multiples of the unit, may be considered as in most ways identical to molecules of that unit, they are absolutely and definitely differentiated from the ordinary chemical hydrogen molecule, by the immense difference in their internal energy. All these groups still retain enough of their original potential energy to constitute them as perhaps several thousand times more energetic than any possible chemical compound. To make a 2 atom from two hydrogen atoms, or a 4 from two 2 groups we should first of all require to give the smaller groups kinetic energy to such an extent that if it was applied to the components of the most stable chemical molecule, and even to some of the elemental atoms themselves, they would be instantly disrupted.

Then we should also expect to find between the figures given above numbers that represent the strongest intermediately developed types. These in our notation may be expressed simply by adding severally to any epoch the numbers representing the

strongest pre-existing types, the results will then represent a-synchronic developments. We thus have—

TABLE I.
GROUP CHARACTERISTICS.

Epoch	Primary	Secondary	Tertiary
1	...	...	...
2	3	4	4
4	6	7	5
8	12	11	14
16	Isologous Series	Homologous Series	...
32	...	...	...

This table shows the primitive atoms or groups that are used in building up the various derived groups of elemental atoms shown in Table VIII, page 79.

These numbers represent what we may call the most recently developed types of primitive atoms, prior to the formation of the 16 group.

Table I. gives us numbers that are truly representative of the development up to this time. If instead of supposing two simple progressions we supposed that there were several, and the progress was geometrical with still the common ratio 2, we get numbers which are still derivatives of our binary progression, so that when we take any term in the latter as representing the hydrogen atom, we still get numbers as the final expression of the several series, which are to the unit taken as the numbers in Table I.

Now, we should expect that further development would consist in compounding these primitive atoms with the latest epoch, 16; and we should further expect that this would lead to a long and important series, all of which should be appreciable by our senses.

If we take hydrogen as consisting of 1024 gyrons, the group 16 will be equal to a binary group of two 8 groups and will contain 16,384 gyrons.

These two 8 groups are very heavy and their real inertia, as distinct from their apparent inertia, is very great. They may therefore be expected to form many synchronic types, having very different holding powers; and also to form static aggregates consisting of various multiples of 16 itself, having selective powers, which in general we may say will attract and hold in orbital motion the largest possible single primitive atom or groups of the same.

In tracing out the subsequent development according to the principles elaborated in this and previous paragraphs, we might suppose that the 8 group was responsible for some of the development. That is to say, that the smaller primitive atoms became attached to multiples of 8, and in this way formed isologous and homologous series using the 8 group as a base. Undoubtedly some of the evolution was accomplished in this way and the same probably applies to the 32 group. It gives, however, exactly the same results if we use the 16 group right through, and this will enable us to present the numerical relations of the atoms in a more concise form, and

one which will better fit in with existing classifications. When, however, it becomes a question of absolute classification, as will be the case in developing the science of Intra-atomic Chemistry, it will be necessary to present the components of the atoms, not in their most convenient form, but in the one which is absolute. It is conceivable that it will make a considerable difference in the disruption of an atom and the subsequent readjustment, whether the base is composed of two 8 groups, or one 16 group. Beyond, however, working out the relations in the next chapter and presenting in the chapter on Dissociation, a feasible method of attack ; it is not proposed to go into the subject of intra-atomic chemistry in these pages. It has no bearing on our present subject other than that, in its most elementary considerations, it allows us to form an absolutely definite conception of the constitution of the atom, without the introduction of any electrical ideas whatever.

We may proceed then to a consideration of the numerical relations of the atoms and of the possibility of fitting these into the evolutionary scheme which has so far been followed.

NOTE.—Only the numerical relations of the elements are here discussed. The evolutionary sequence, as regards relative time of appearance, of a few of the most primitive types, is dealt with in the Appendix.

CHAPTER III.

NUMERICAL RELATIONS OF THE ATOM.

"The next view which included the same idea—that is to say, a physical connection between these different things as opposed to the view that they were manufactured articles, special creations, each without any relation whatever to the other—was suggested by Dobereiner in 1817, and the idea was expanded by Pettenkofer in 1850. Both pointed out that there were groups of three elements, such as lithium, sodium and potassium, numerically connected; that is, their atomic weights being 7, 23, and 39, the central atomic weight was exactly the mean of the other two, $7 + 39 = 46$, divided by 2, we get 23. Another way, however, of showing that is that $7 + 16 = 23$, and $23 + 16 = 39$; the latter method suggests a possible addition of something with an atomic weight of 16.

Inorganic evolution as studied by Spectrum Analysis. P. 165. By Sir Norman Lockyer, K.C.B., F.R.S.

"The properties of an element are a periodic function of its atomic weight." So reads the Periodic Law, a concise statement of fact, as mysterious as it is irrefutable. The Periodicity, the Triads, and other simple relations will be found to be sufficiently explained if we make proper use of the "something with an atomic weight of 16."

CHAPTER III.

NUMERICAL RELATIONS OF THE ATOM.

P. 16. First of all we must consider collectively all the well-known elemental atoms of which our planet is built up. We may take Table II., as probably the very latest authoritative expression of science on the subject of atomic relations. This table is based on the classification of the late eminent Russian chemist Mendeleef. The numbers represent the ratios of the weights of the different atoms to the hydrogen atom, which however is taken as 1.008, so as to allow of oxygen being taken as 16. This table was arranged by Mendeleef to show three different relations:—

- (1) Numerical, left to right.
- (2) Chemical relationship of members of series, left to right.
- (3) Chemical relation of members of groups, up and down.

That is to say, the table is arranged first of all according to numerical sequence, and secondly so that if you consider any element, it is related in its specific chemical qualities to both the members of the series and the members of the group in which it stands.

P. 17. To uphold our theory of atomic evolution then, the task which we have in front of us is:—

(1) To show that the members of any series, reading from left to right, are composed of the same multiple of 16 added to characteristic numbers, which represent the different primitive groups. (Isologous series).

(2) To show that the members of any group, reading down, are composed of multiples of 16, added to multiples of the characteristic of that group. (Homologous series).

To establish (1) I give series 3, 4, 5, slightly rearranged and omitting for the present group VIII.

In each case the same multiple of 16 is carried through the series. There is no other number which will give so close a concord.

To establish (2) I give group I.

Ascending multiples of 16 are carried through the group. There is no other number which will give so close a concord.

It must be admitted that, even if this is the only group in Table II. that shows such a close serial sequence, it is still a most remarkable fact that it does so.

We have supposed that the motion of the 16 groups is different. They will thus attach themselves to the groups which are best suited to their own strength. The internal motion is therefore roughly graded from

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the first group up to the last shown in Table III. Now in going down any one of these groups it is quite easy to conceive that the holding power would not increase at exactly the same rate as the number of bodies forming the central aggregate. Thus whilst four 16 groups might exactly balance three 8 groups, nine 16 groups might only be able to hold seven 8 groups.

The first break in the continuity occurs in group II., and it will therefore be given to illustrate the point.

Here it will be noticed that a change in the relations of what we may call the x and y groups, occurs at or after the eighth multiple of sixteen. That is to say the holding power of 8 (16) falls short of that which is necessary to retain 7 (8). Also in subsequent groups a similar change occurs at the fourth multiple.

We may express the change by saying that the serial relations of the atomic weights in any group may be roughly expressed by the empirical formula, $mx + (m \pm n)y = w$, in which $x = 16$, y = the top or characteristic member of each group, m = the number of the series from 1 to 10, and n = an indeterminate positive or negative integer lying between 0 and 5, and apparently dependent on $\frac{mx}{(m-1)y}$.

It is of course obvious that only an approximation is obtained in most cases, but the approximation is so close that it cannot be considered as the result of pure accident. In the two groups given in Tables IV. and V., the total number of gyrons concerned is not less than 1,593,630 if we put the hydrogen atom at 1024. The total difference between the calculated

and experimentally determined weights is 12,155 or .76%, surely a result that must mean something.

That the atom has been evolved haphazard is a contention that probably no man will uphold. The only other alternative is that they have been evolved according to a system and that their weights must follow absolutely some definite numerical series. The one suggested here may or may not be the right one, but if the right one is ever found, assuredly there will be a divergence, for in the laboratory the personal equation can not be entirely eliminated. Anyone who knows the methods employed in determining the relative weights of the atoms will admit the possibility of error.

No matter what the methods employed in the determination of these weights, and no matter how carefully the method may be adhered to, there is still a possibility of error; for if the atom has any such constitution as is here supposed, it may actually have different weights under different conditions. It is quite within the bounds of possibility, and in this theory is a necessity as we shall see presently, that the motion of the y groups for instance, may vary within narrow limits, and one or other of these limits may be approached according to the temperature or the state of chemical combination of the atom. It is quite possible that this slight alteration may cause a difference in the total absolute attraction of the atom for the earth. A compound then of two elements might weigh $(x+y)$, yet separately, the constituent elements may weigh $(x+m)$ and $(y-m)$. A definite

TABLE II. (after Mendeléef.)

Series	Zero Group	Group I.	Group II.	Group III.	Group IV.	Group V.	Group VI.	Group VII.	Group VIII.
1	...	Hydrogen H = 1.008	...	...	...	...	...	...
2	Helium He = 4.0	Lithium Li = 7.03	Beryllium Be = 9.1	Boron B = 11.0	Carbon C = 12.0	Nitrogen N = 14.04	Oxygen O = 16.00	Fluorine F = 19.0	
3	Neon Ne = 19.9	Sodium Na = 23.05	Magnesium Mg = 24.1	Aluminium Al = 27.0	Silicon Si = 28.4	Phosphorus P = 31.0	Sulphur S = 32.06	Chlorine Cl = 35.45	
4	Argon Ar = 39.9	Potassium K = 39.1	Calcium Ca = 40.1	Scandium Sc = 44.1	Titanium Ti = 48.1	Vanadium V = 51.4	Chromium Cr = 52.1	Manganese Mn = 55.0	Iron Fe = 55.9 Cobalt Co = 59 Nickel Ni = 59
5	...	Copper Cu = 63.6	Zinc Zn = 65.4	Gallium Ga = 70.0	Germanium Ge = 72.3	Arsenic As = 75.0	Selenium Se = 79.2	Bromine Br = 79.25	
6	Krypton Kr = 81.8	Rubidium Rb = 85.4	Strontium Sr = 87.6	Yttrium Y = 89.0	Zirconium Zr = 90.6	Niobium Nb = 94.0	Molybdenum Mo = 96.0	...	Ruthenium Rhodium Ru = 101.7 Rh = 103.0 Palladium Pd = 106.5
7	...	Silver Ag = 107.9	Cadmium Cd = 112.4	Indium In = 114.0	Tin Sn = 119.0	Antimony Sb = 120.0	Tellurium Te = 127	Iodine I = 126.85	
8	Xenon Xe = 128	Cesium Cs = 132.9	Barium Ba = 137.4	Lanthanum La = 139	Cerium Ce = 140	...	...	...
9	...	...	...	...	...	...	...	...
10	...	...	...	Ytterbium Yb = 173	...	Tantalum Ta = 183	Tungsten W = 184	...	Osmium Iridium Os = 191 Ir = 193 Platinum Pt = 194.9
11	...	Gold Au = 197.2	Mercury Hg = 200.0	Thallium Tl = 204.1	Lead Pb = 206.9	Bismuth Bi = 208.5	...	...
12	...	...	Radium Rd = 224	...	Thorium Th = 232	...	Uranium U = 240	...	

TABLE III.
SERIES 3, 4 AND 5 OF TABLE II.

Characteristics	3	4	7	8	11	12	14	16
Series 3.	F=19 16+3=19	Ne=19.9 16+4=20	Na=23.05 16+7=23	Mg=24.1 16+8=24	Al=27 16+11=27	Si=28.4 16+12=28	P=31 16+14=30	S=32.06 16+16=32
" 4.	Cl=35.45 32+3=35	Ar=39.9 32+4=36	K=39.1 32+7=39	Ca=40.1 32+8=40	Sc=44.1 32+11=43	? Ti=48.1 32+12=44	? V=51.4 32+14=46	? Cr=52.1 32+16=48
" 5.	...	...	Cu=63.6 48+14=62	Zn=65.4 48+16=64	Ga=70 48+22=70	Ge=72.3 48+24=72	As=75 38+28=76	Se=79.2 48+32=80

This Table shows that the same multiple of 16 is carried through each series and when added to a regular multiple of the top member of any group gives a close approximation to the atomic weight of any element in that group.

NOTE—The total number of gyrons concerned in this table is 1,002,045, taking Hydrogen at 1024. The total error is 12,944 or 2.4%. Three elements, Ti, V and Cr account for 55.8% of this error.

TABLE IV.
GROUP I. OMITTING H.

New Series	Old Series	Component Groups	Elements	Calculated Weights	Table II Weights	Difference	n
0	2	Characteristic	Li	7	7.03	.03	...
1	3	1 (16) + 7	Na	23	23.05	.05	0
2	4	2 (16) + 7	K	39	39.1	.1	1
3	5	3 (16) + 2 (7)	Cu	62	63.6	1.6	"
4	6	4 (16) + 3 (7)	Rb	85	85.4	.4	"
5	7	5 (16) + 4 (7)	Ag	108	107.9	.1	"
6	8	6 (16) + 5 (7)	Cs	131	132.9	6.1	"
7	9	7 6	...	...	...	...	...
8	10	8 7	...	...	...	...	...
9	11	9 (16) + 8 (7)	Au	200	197.2	2.8	"
10	12	...	...	...	...	...	...

The regular ascending value of the groups that make up the atoms of the Lithium—Gold group is shown in this Table. Compare Table II.

TABLE V.
GROUP II. OF TABLE II.

New Series	Old Series Table II.	Component Groups	Element	Calculated Weights	Table II. Weights	Difference	n.
0	2	Characteristic	Be	8	9.1	1.1	...
1	3	1 (16) + 8	Mg	24	24.1	.1	0
2	4	2 (16) + 8	Ca	40	40.1	.1	1
3	5	3 (16) + 2 (8)	Zn	64	65.4	1.4	"
4	6	4 (16) + 3 (8)	Sr	88	87.6	.4	"
5	7	5 (16) + 4 (8)	Cd	112	112.4	.4	"
6	8	6 (16) + 5 (8)	Ba	136	137.4	1.4	"
7	9	7 6	...	...	...	...	"
8	10	8 7	...	...	...	...	"
9	11	9 (16) + 7 (8)	Hg	200	200	0	2
10	12	10 (16) + 8 (8)	Rd	224	224	0	"

The regular ascending values of the groups that make up the atoms of the Beryllium-Radium Group is shown in this Table. Compare Table II.

reason for this supposition will be given later on. As a further possible explanation of a divergence, there is a possibility that many of the atoms have not yet been assigned to their correct groups.

The discovery of new elements may entirely and reasonably change the relative position of a whole group. As an instance of this Table VI. is given. If we suppose, as in Table I., that there is a secondary, derived atomic type, whose atomic weight is 3, and giving n a + value first in the helium group, at the critical point, series 4, and a symmetrical value in the 3 group, we may make the disposition as shown.

In support of the possibility of the existence of such an atom, it may be here pointed out that the spectrum of what are supposed to be the very hottest stars, shows the lines of hydrogen, helium, and of other unknown types. Whatever the actual physical characteristics of these unknown types may be, to be thus authoritatively classed with H and He, they must be amongst the most primitive forms developed, and therefore must have atomic weights not differing by any great amount from the weights of those that are recognisable. We may take it as extremely probable that not only does such a type exist, but that there are also other primitive types of which at present we know nothing.

In further illustration of this point, and also because it illustrates the different relations which must exist between the x and y groups, the whole of series 5 is given with the extensions possible, if more elementary types are conceded.

TABLE VI.

FLUORINE GROUP. HELIUM GROUP.

Series	Component Groups	Ele- ments	Calculated Weights	Group VII Table II.	n	Component Groups	Ele- ments	Calculated Weight	Zero Group Table II.	n
...	Characteristic (unknown)	...	3	3	...	Characteristic	He	4	4	...
1	16+3	F	19	19	0	16+4	Ne	20	19.9	0
2	2 (16)+1 (3)	Cl	35	35.45	-1	2 (16)+1 (4)	Ar	36	39.9	-1
3	3 2½	...	...	...	-½	3 2	...	...	...	-1
4	4 (16)+5 (3)	Br	79	79.95	+1	4 (16)+4 (4)	Kr	80	81.8	0
5	5 7½	...	...	...	+2½	5 6	...	...	...	+1
6	6 (16)+10 (3)	I	126	126.85	+4	6 (16)+8 (4)	Xe	128	128	+2

This Table shows the derivation and analogy of the Fluorine and Helium groups. The chemical qualities of the two groups are explained at once by this classification.

TABLE VII. SERIES VI. (TABLE II.)

H. Group	Fl. Group	He. Group	2/2	3/1	4/1	4/2	7
...	Mn=55 $48+2(4)=56$	Fe=55.9 $48+2(4)=56$	Co=59 $48+2(5)=58$	Ni=59 $48+2(6)=60$	Cu=63.6 $48+2(7)=62$
...					

8	11	12	14	16
Zn=65.4 $48+2(8)=64$	Ga=70 $48+2(11)=70$	Ge=72.3 $48+2(12)=72$	As=75 $48+2(14)=76$	Se=79.2 $48+2(16)=80$

Suppose we take the material that the helium atom is built of, but before it has reached the stage at which it is fitted for forming that atom and also have sub-types, wherein the three group interacts with similar groups, and also with dissimilar antecedent groups, we might arrange series 5 as in Table VII.

This arrangement would find a natural position for the whole of group VIII. in Table II., and it must certainly be admitted that in that table their position lacks definition.

There are many other points of interest in a table arranged according to the principles outlined above, but their elaboration would require more space than can be given to them here. At present we can only aim at pointing out a direction in which further investigation might be productive of good results.

Table VIII. shows the rearrangement of the elemental atoms which becomes necessary under this scheme.

This arrangement affords a reasonable explanation of the density of osmium and similar metals. These metals lie closest to the part of the table where the greatest density would naturally be expected.

Drawing a line from osmium to sulphur we pass through the position of mean density, and here we have density and mobility combined to give us "electrical" and thermal conductivity, according to the considerations to be developed presently.

Now, if in working up the relations of any group we substitute for x any other number than 16, or if for y we take any other number than the characteristic

TABLE VIII.

(COMPARE WITH TABLE II.)

Derivation of Characteristic Groups.	See also Table I.	1	2	2/1	4	2/2	3/1	4/1	4/2	4/3	8	8/3	8/4	8/6	16
		1	2	3	4	4	4	5	6	7	8	11	12	14	16
Primitive Series	0	H	...	...	He	...	...	...	...	Li	Be	B	C	N	O
New	1	16	...	F	Ne	...	...	...	...	Na	Mg	Al	Si	P	S
	2	32	...	Cl	Ar	...	...	...	...	K	Ca	Sc	? Ti	V?	Cr?
	3	48	...	...	...	Ma	Fe	Co	Ni	Cu	Zn	Ga	Ge		Se
Series	4	64	...	Br	Kr	...	...	...	...	Rb	Sr	Y	Zr	Nb	Mo
	5	80	...	...	...	...	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te
	6	196	...	I	Xe	...	...	...	...	Cs	Ba	La	Ce	...	..
	7	112	...	...	...	...	...	...	...	...	...	...	...	...	...
	8	128	...	...	...	...	Os	Ir	Pt	Au	Hg	Tl	Pb	Ta?	W?
	9	144	...	...	...	...	...	...	...	...	...	...	...	Bi?	...
	10	160	...	...	...	...	...	...	...	...	Rd	...	Th	...	U

This Table shows the re-arrangement of Table II. which becomes necessary under the general scheme outlined in these pages.

given above, we find that the divergence from the series will be increased. How can this be explained? That some simple numerical relation should exist is to be expected, that it does exist is indisputably shown in Tables IV. and V. If we ask, why does it exist?—it might be argued that it is accidental, or that it has no particular meaning. But to support this contention, we could point to no parallel in the whole universe. If we find a law that apparently has no meaning, the fault is ours. Nature does not rely on accident to establish its foundations, nor build on facts that have no meaning. We may take it then that there is an explanation. The one that is offered here will do until in the ordinary course of events a better supplants it. If it is better it will be simpler, and if it is that, no further justification will be needed.*

*The relation shown in Table IV. and V., which with perfect regular changes in the value of n , extends throughout the whole of Table VIII. is, as far as is known, entirely a new discovery. It was communicated to the editors of the *Philosophical Magazine* in a letter dated April 20th, 1907.

CHAPTER IV.

THE MOLECULE.

Consider a molecule of any common mineral, say Sulphate of Mercury—a comparatively simple case. Its chemical formula is $Hg\ SO_4$, and its intra-atomic chemical formula is

$$[9\ (16) + 7\ (8)] + [16 + 16] + [16]_4$$

It thus consists of 6 atomic groups, or 22 primitive atoms, or 294 principal subgroups, or 303,104 restricted gyrons. Each of these atoms, primitive atoms, and subgroups has a distinctive and characteristic motion of its own.

It is thus plain that a steam locomotive is a simple piece of mechanism compared with a molecule of Mercuric Sulphate.

CHAPTER IV.

THE MOLECULE.

P. 18. We have now got a number of systems wrongly called atoms,* which are built up of smaller systems. Each of these systems is complete within itself, just as each subsidiary system is complete within itself. They are kept together as complete systems of systems by the simple attractive power of the units, developed and applied according to our four simple principles. Some of these units are yet kept apart by their great velocity and consequent eternal tendency to follow a straight path. Their motion is the resolution of the potential energy with which each was invested when it was given a place in the universe; supplemented by small increments derived from external sources in accordance with a method to be developed later. Such a material system would sooner or later arrange itself so that all its subsidiary systems would be revolving as nearly as possible in one plane, which we may call the principal plane of the system. We may consider each system as entirely complete in itself, not as being indestructible but as having a sufficient measure

* Atom, from α , not, and $\tau\epsilon\mu\omega$, I cut.

of indestructibility, by reason of its motion, to preserve under ordinary circumstances its individuality and general characteristics. We may think of the majority of these atomic systems as having a central sun (x groups), with planets (y groups), moving rapidly round it in practically concentric orbits. From principles laid down in former pages we know that if two such similar systems are brought close together, the resultant of the interaction of all the orbital motions will be to bring the systems as close together as possible with their principal planes parallel and their centres as near together as circumstances will allow.

We thus have a basis for forming further systems on the same principle as the others. If a mixture containing a number of dissimilar elements is strongly heated, the different atoms are thrown into a state of violent agitation. On a very much smaller scale they are in an identical state to that through which their constituents have already passed. In re-establishing a state of equilibrium some of the atoms will retain an excess of energy longer than others. On slightly heating a heterogeneous liquid mixture, some of the atoms will acquire an excess of energy quicker than others. In both cases the larger atoms will acquire the smallest degree of translative motion. In both cases then we have conditions under which single atoms or aggregates of atoms may form central nuclei, around which smaller and more mobile atoms may be compelled to move in orbital motion.

Any such combination of atoms whether existing

as a static aggregate of similar atoms complete in itself, or as having similar or dissimilar atoms attached to it we may call a molecule.

There are many thousands of such combinations that may be formed from the material which we now have at our disposal. It is obviously impossible to trace out any general numerical relation that will apply in all cases to the combinations that are possible. All that it is necessary to show, to fulfil our requirements, is that whatever the plan of atomic structure may be, that of the molecule may be considered as offering a close analogy. Whatever the construction, we should have to develop no new laws nor general principles, for the material of which the molecule is built up differs from that used in the construction of the atom, only as regards relative mass and the degree of motion which is possible.

As has been shown, the planetary conception so far used will explain the evolution of the atom, and there seems to be no good reason why it should not also be used to explain molecular construction and general chemical relationship. Our four principles are just as much applicable to the molecular construction as to the atomic, and if the conditions are the same they must act in the same way. It will, however, tend to consolidate our scheme as a whole, if we can show some analogy between the general action of some of the most common molecular constituents and that of some of the theoretical components of our atomic systems.

The principal theoretical attributes which have

been supposed to govern the evolution of the atom are entirely due to the difference in mass and orbital velocity of the principal groups concerned.

The very essence of the whole conception is that under different degrees of motion the same group may have very different intra-atomic chemical qualities.

The principal deductions from this view are backed up by the relations which have been shown to exist between the members of the different groups and series in Table VIII.

The most important relations which we have found to exist between the parts of the atom tend to show that it is, itself, a more or less complex molecule of pre-existing types. At least it is hard to explain Tables IV. and V. under any other supposition. The elements included in these groups or in any other are related to one another and are placed in that particular group mainly on account of their chemical attributes. Why there should be a difference or a similarity between any two atoms becomes at once entirely explicable if they are considered as built up of the same or different materials, the proportions only being different. This supposition usually involves also very different states of internal motion, and this in conjunction with the similarity or dissimilarity of the components may quite reasonably be called upon to explain the chemical qualities of any such atomic system as a whole.

We have as the two main possibilities of the application of the general idea, that first of all, the same

group if it is strong and elastic, is capable of existing in many different phases of internal motion, and that in consequence of this difference its static attraction and general effect on other atoms varies very materially. We thus find group 16 a recurrent factor in every whole series, it having entered into combination, in its various phases, with each of the principal pre-existing types. These combinations, when tabulated, may be called intra-atomic isologous series.

Again we find that multiples of the same phase of group 16 retain their selective affinity for whatever group they first found most suitable, and they consequently go on attracting more and more of these as larger multiples come into existence. In bringing about this result the internal motion of the smaller body must undoubtedly have its effect also, for its attraction is greater for its own kind than for any other.

We have seen also that the magnitude of the holding power of any multiple or aggregate does not exactly keep pace with the magnitude of the multiple concerned. There is a slight difference, and this difference has been reduced to a numerical expression in the value of n . The value of n never exceeds 5. Its highest positive value is at the hydrogen side of Table VIII., and its highest negative value at the uranium end of that table, whilst in the lithium group it has its nearest approach to the constant value, 1. This factor n has been called an indeterminate, because for our purpose it is not necessary to go into

a mathematical analysis of the orbital differentiation which its exact determination will involve. It would prove nothing if the general conception is wrong.

P. 19. Now what we want to show is, that amongst the combinations which the elemental atoms are capable of forming themselves into, there exist groups and series analogous to those which are used in the explanation of intra-atomic relations. It is necessary then to look for—

- (1) Isologous series, wherein the same atom or group of atoms may be considered to have very different holding powers.
- (2) Homologous series, wherein different multiples of the same atom may be considered as holding together different multiples of a smaller group. Also that in this case the value of n varies.

It is necessary to show also that even amongst such relatively large bodies as the atoms, there are mass phases which are only explainable by supposing them analogous to the a-synchronic developments of group 16.

The qualities required in an atom to fit it for serial developments are—(1) Simplicity of internal structure and—(2) Sufficient mass to bring the centre of gravity of any system formed very close to its own centre.

Next to group 16 we find these qualifications best exemplified in the $(8+4)$ or carbon atom.

Whilst there are many other elements whose combinations afford examples of simple or complex series, amongst the carbon compounds will be found the longest and most regular, and these will best illustrate the case.

As an example then of an isologous series composed of atoms we may take the Butane series.

Butane	$C_4 H_{10}$	$mx + (m + 6)y$
Butene	$C_4 H_8$	$mx + (m + 4)y$
Butine	$C_4 H_6$	$mx + (m + 2)y$
Butone	$C_4 H_4$	$mx + (m - 0)y$
Butune	$C_4 H_2$	$mx + (m - 2)y$

We see that here the value of n varies between $+6$ and -2 . In the first member, the carbon atom is holding $2\frac{1}{2}$ hydrogen atoms whilst in the last it is holding only $\frac{1}{2}$ a hydrogen atom, and yet any of these compounds are perfectly capable of existing in a free state, that is to say they are to a certain extent in a stable condition.

If now from the $C_4 H_{10}$ molecule we take away one hydrogen atom, instead of two, to form the butene molecule, we obtain a molecule which cannot exist alone; and there is every reason to suppose that if we were to take away any part of one of the built up atomic systems the same thing would happen. In both cases the system has so arranged itself that with neither more nor less absolute mass can it retain a measure of stability.

As an example of an homologous series composed of atoms, we may take the Methane series—

Methane	C H ₄	$mx + (m + 3)y$
Ethane	C ₂ H ₆	$mx + (m + 4)y$
Propane	C ₃ H ₈	$mx + (m + 5)y$
Tetrane	C ₄ H ₁₀	$mx + (m + 6)y$
Pentane	C ₅ H ₁₂	$mx + (m + 7)y$

Here we see that the carbon atoms represent an ascending series similar to that shown in Tables IV. and V., wherein different multiples of group 16 are associated with multiples of a smaller primitive atom. The holding power of the carbon atom varies throughout the series from 4 to $2\frac{1}{2}$.

The manner then in which the carbon atom associates with the hydrogen atom seems to bear a close analogy to that in which group 16 associates with primitive atoms and groups. In either case it is difficult to see how any feasible explanation can be offered without introducing the idea of motion.

P. 20. It is not alone in the compound molecule that we can see difference of chemical and physical qualities, which may be considered as due to different states of internal motion. In many simple molecules, consisting as far as is known of the atoms of but one element, there are phases of existence which appear to be most difficult to explain, unless we admit the possibility of the spontaneous attainment of temporary stability at various stages in the dissipation of abnormal energy.

Isomerides or chemical compounds having similar compositions, but differing often considerably in their chemical and physical properties, owe their difference, not to difference in composition because none can be

observed, but to their constitution, or in other words to the method in which their constituent atoms have come together. Under different conditions as to temperature, sulphur for instance will take on different forms; but it is noticable that there are few if any isomeric forms of this or any other element or compound that are not purely transitionary, and if left to themselves under suitable conditions will revert to some simpler and more stable forms. This shows that their temporary state is one that is dependent on the degree of motion or energy within the system. The existence of very stable allotropic forms of certain substances also illustrates the case. Take the case of carbon. Amorphous carbon and the diamond are both carbon, and yet in appearance and properties are very different. If these bodies are burnt, the decomposition or disruption of their molecules sets free different amounts of energy in the form of heat. We might conclude from this that in the form of diamond or as amorphous carbon, the progress of a number of carbon atoms from a higher state of energy to a lower has been arrested at two different points. This may be caused by internal or external conditions, or by both; no matter what the reason the fact itself seems to be beyond dispute. In both cases the induced physical state may be purely transitionary, and the systems concerned may be spontaneously giving up energy. There is indeed very good reason for supposing that this is the case. The conclusion seems to be irresistible that the atoms have been forced into a position of temporary stability, and that it may take

a very long time for this stability to be upset if no outside force is used. This principle is exactly what is necessary in our conception of the relations of the atoms of various elements. The devolution of the system 16 has been arrested at various stages, and each of these stages represents a member of the first series in Table VIII., and multiples of these stages the subsequent steps in the various groups. We may also suppose that in bygone ages this same process has been gone through with the other simpler epochs 2, 4, 8, and that the devolution has been carried as far as is possible with respect to these groups, just as after many millions of years it may reach the lowest limit in respect to group 16. The elemental atoms that we know may thus reasonably be divided into various well marked series, which are in their ultimate analysis simply molecules of primitive elements ; some of which owing to the change in conditions are now unable to exist except as components of a complete system. The state of motion which is necessary to preserve their individuality as atoms seems to present to us but one possibility.

We know that it is possible to take a mass of pure carbon, raise the potential energy of the constituent atoms and then arrest the devolutionary process at the stage which is known as graphite, density 2.2 or as the diamond, density 3.3. The number of heat units evolved by the combustion of these two forms are to one another about as 93,240 is to 93,360. There is thus very little difference in this respect, and their composition is identical, so that these two forms

must represent purely molecular effects in which the bodies concerned are placed in a perhaps transitory, but still great state of stability. These two forms must be owing to slightly different states of motion. It is difficult to conceive what these different states of motion can be, unless we admit them to be orbital; for no other form of motion would appear to have the required degree of even temporary stability and to be at the same time capable of preserving the individuality of the phase forms.

The different forms of carbon, sulphur and other elements thus seem to afford ample support to the possibilities attached to the much more elastic and energetic group 16.

P. 21. We have seen that this group has had a great importance in the development of the atomic systems, and therefore leaves its impress on their relative weights. To get anything like a symmetrical series representing these weights we must in fact use multiples of this number. According to our hypothesis, the primitive system, which of all others still preserves the largest residue of the original potential energy of its constituent groups, is the group 16. If its constitution fitted it for entering so largely into the construction of the atom, it would be most surprising if it was not thereby fitted for entering largely into the construction of the molecule. Whilst then, considerably more than half the entire weight of the atomic systems may be considered as made up of multiples of this group, it is not surprising that in its highest development, as the oxygen atom, it enters

very largely into composition of the objects around us. It does in fact make up about half of the total weight of the earth's crust, the greatest molecular aggregate of which we may be said to have any direct knowledge.

P. 22. In the construction of an atomic molecule we usually have to introduce more or less heat. It will be shown later that this simply results in pushing apart the atoms which we wish to combine. We give them in fact potential energy with respect to one another, which they at once proceed to give back in the form of heat in coming down to a position of stability; and in performing this process they are following the example of the gyrons in the first stages of their existence. In both cases to disturb the stability thus obtained, we must reproduce the initial circumstances, we must add energy to the system thus formed. Generally, we may say that any chemical changes that take place tend towards stability if they spontaneously deliver up energy, and towards instability if they require to have energy added. Here again we have a close analogy. The atomic types which we know to be the most stable are at the same time the least energetic. They have spontaneously given up the greater part of their internal energy millions of years ago. But if they would require an enormous amount of energy to disrupt them now, it is also true that when they were first forming they must have possessed an amount of energy of which at present we can hardly form a concrete conception.

In the beginning of things the gyrons were given a position of instability with respect to one another, which they proceed to change into a position of stability. When given their place in the universe they were also thereby given a fund of potential energy and the more of that original energy they have given out, the greater their present state of stability. So it is with the molecular system. By adding heat to a mixture we give the systems potential energy with respect to one another, and we may even give them sufficient internal energy to cause disruption. Usually they give out some of their energy in attaining stability in the form of a new system or compound; and they give out an exactly equal amount of energy to that which they have absorbed, if by subsequent processes, they are induced to return to their original state.

In all cases they conform to the general "principle of maximum work." They will, if possible, try to reach a lower stage than the original; and, if successful, will in so doing give out more energy than the amount that was originally given to the mixture; and the lower the stage thus reached the more energy will be required to disrupt the system formed. This is an elementary principle of chemical combination, and is also entirely applicable to intra-atomic combination. In some of the primitive types, such as hydrogen and helium, the systems have reached such a stage of stability that energy hardly exists in a natural form that will disturb that stability.

It is difficult to conceive how this conformity is

possible without conformity of structural principle. If one is a planetary aggregate, so must also be the other.

These various considerations make it appear that we are justified in considering the molecule as a system which is in a similar state of motion to the atom. Just as the atom is an aggregate of smaller primitive atoms, so is the molecule an aggregate of elemental atoms. Whatever constitution we assign to one, we are justified in assigning to the other.

We may say then that the molecule is a system, similar in form to the atom, but made up of very much larger bodies. The orbital area is thus very much greater, but the relative velocity very much less.

P. 23. Since the form of the molecule is similar to that of the atom, it must act towards external bodies and forces in a somewhat similar manner. It must always have a more or less strong attraction for any other molecule, and from this cause masses of matter are formed. As a system, the molecule may have but little attraction for a single atom of any element; but by adjusting the internal motion of a molecule, usually by adding or subtracting heat, a foreign atom may be admitted into the system to the exclusion of or in addition to any of the existing members. Its principal attractive effort is generated normal to its principal plane and is of the same form as the atomic and gyronic ether motion; but is necessarily of much greater amplitude and still smaller penetrative powers and intensity, and is operative as between two molecules, only when a relatively small space intervenes.

Mass cohesion is thus the resultant of the action of several different forces, which however are similar in character but vary in intensity. The different systems composing the mass each does its part in preserving the solidarity and inter-mass relations of the whole, but does it in a way that is characteristic of the type to which it belongs. The effect which each one produces is due to the ether motion induced by it, and the intensity and amplitude of this, are representative of the internal energy and other characteristics of the system that caused it.

The gyron comes first with the highest limit of intensity and the smallest amplitude; whilst the molecule comes last with the smallest limit of intensity and the highest amplitude.

CHAPTER V.

HEAT AND LIGHT.

The molecule of an element must have within itself inherent properties which are the cause of gravity, intra-atomic attraction, chemical affinity and mass cohesion. In addition it must produce a spectrum, characteristic of itself alone, and consisting of perhaps a thousand lines. If these requirements render necessary a complicated internal mechanism, they must also, not less certainly, insure a beautiful simplicity and rhythm in the operation of that mechanism.

CHAPTER V.

HEAT AND LIGHT.

P. 24. We have seen that any system revolving in one plane about its own centre of gravity, at a high velocity, may be depended on to develop two entirely different classes of ether motion or force, according to which part of the system we consider, these are :—

- (1) From the sides, the Alpha-force.
- (2) From the periphery, the Beta-force.

We have so far only outlined the results which the Alpha-force is capable of producing, and now it becomes our business to look into the possibilities of the Beta-force.

The Alpha-motion is in all cases of a helicoidal or spiral form, and produces its effects by decreasing the pressure on one side of a system, the effect produced being proportional to the snychronism of the interacting bodies.

The Beta-force is of a transverse vibrationary or wave form, and we have now to show what effects it produces; and also that it produces these effects in an exactly opposite manner to the Alpha-force, namely, by increasing the pressure on one side of a

body, and also that whatever effect is produced is proportionate to the synchronism of the interacting bodies.

We may say generally of the two forces that a body which is under the influence of the Alpha-force is usually dissipating energy, whilst a body which is under the influence of the Beta-force is usually gaining energy.

If the universe had, in the beginning, been left subject solely to the Alpha-force, it would have lost the greater part of its energy long ago.

The function of the Alpha-force is to cause motion, to change the potential energy of the gyron or other system into a more negotiable form. In doing so, in the beginning, it caused the multitudes of these little bodies to change their state from one of infinite dispersion to one of finite consolidation.

The function of the Beta-force is to make use of one form of the kinetic energy created by the other. No body or system can move any where in the universe in orbital motion without causing the generation of some form of Beta-force, and thereby transmitting a portion of the energy which it is using up to points that are far distant. The Beta-force is the distributor of energy from points at high potential to points at low potential, from the radiant star to the one that is nearly cold, from the sun to the earth, from every point where there is much energy to every point where there is little. It is the leveller-up and the conservor. The Beta-force has thus been of quite as much importance as the

Alpha-force in bringing the universe to its present stage.

P. 25. We must now consider two simple little instruments that illustrate at once the principle of the action of the Beta-force.

The radiometer is the first of these instruments. This little instrument is of the utmost importance, because it establishes beyond question the existence of the ether, and the tremendous energy that can be transmitted through it by means of wave motion of the Beta-form.

Just as a wind-mill, set up in the open will rotate when exposed to air motion, so will the little vanes of the radiometer rotate, when closed up in a vacuum, and exposed to ether motion, of Beta-form. A light wave coming 93,000,000 miles through the ether from the sun to the vane of the instrument, has still sufficient energy to cause the little wheel to rotate at a velocity that the eye cannot follow. When we consider that this little vane is composed of millions of molecules, atoms, primitive atoms and gyrons, we can see at once that if the effect is so great on the vane, that the eye is unable to follow its motion, the impact of light and heat on any of its constituents, singly, would be productive of almost inconceivable motion.

As instances of what the mechanical pressure of light* is able to do we might cite many cases, but perhaps the most striking will be the case of a

* Clerk-Maxwell, 1873.

comet's tail, which may be readily explained as the result of this agency.

According to calculations made by Sir Isaac Newton the great comet of 1680, in two days, emitted a tail which was about 60,000,000 miles in length. That is to say that the particles of matter of which that tail was composed had moved during that time at an average velocity of 340 miles per second. Now when we consider that probably none of these particles consisted of less than 1000 gyrons, and most of them probably at least 20,000, we see at once that a gyron if perfectly free might be expected to move, under the influence of solar light alone, even at a distance of 93,000,000 miles, at a velocity of not hundreds but thousands of miles per second.

It is plain that this consideration will apply also proportionately, to all the small elementary bodies which are composed of gyrons.

P. 26 The next instrument which we have to consider is that simple little machine for creating aerial vibrations, known as the tuning fork.

The point that particularly interests us in this instrument is the fact that it may be caused to vibrate by the simple proximity of a vibrating instrument which is similarly attuned.

If we mount say a B fork on a resonator and, without touching it with any material object, approach close to it, a C fork which has been caused to vibrate, we find that the B fork is unaffected. But if we now take a second B fork which is tuned to the same pitch as the first, and causing it to vibrate, approach it close

to the first, without touching, we find at once that the first B fork immediately responds to the influence. The explanation is simplicity itself. The prongs of the first fork are caused to vibrate through an infinitely small space, in a somewhat similar manner to a pendulum. Just as the pendulum may be kept in continuous motion by administering to it a slight push just at the critical moment when it has finished one vibration and is just starting on another, so the prongs of the tuning fork may be caused to vibrate continuously, by administering to them a slight push just at the critical moment that a new vibration is starting. The function of the second fork is to administer this slight push. If the second fork was not absolutely in tune, then the push would not come at the right time and even though it might cause a few vibrations to take place, it would very soon be in opposition to the induced motion and would thus stop it. We thus see that to produce the full effect in the first fork, the second must be absolutely synchronised.

With the help of these two simple instruments we are now in a position to understand the principle of the universal conservation of energy. In the use of the term "conservation of energy" here, it must be expressly stated that it is not meant to convey the idea that the total energy of the universe is absolutely conserved. As a matter of fact, the universe as a whole may be continuously suffering a slight loss. Energy is ostensibly conserved, because if it exists under high potential in any part of the universe, it is the more easily passed on to any other

part which is at a low potential, by the mechanism now to be explained. Every star or sun which is in an incandescent state, is a centre of energy at high potential, and is continually transmitting energy to other parts of the universe; but it is important to remember that it is also continuously receiving energy from all parts of the universe, so that whatever evolutionary process it is undergoing represents a balance between the outgoing and the incoming energy. A great part of the energy is thus conserved as between different points in the universe, but no proof can be adduced in support of the supposition that the total energy is absolutely conserved.

P. 27. The application of the principle of the two simple instruments which we have considered, gives us the exact data that we require, to form an idea of the mechanical interchange of energy from one system to another. Suppose we have two systems A and B, (Fig. 2) identical in every respect. We may sup-

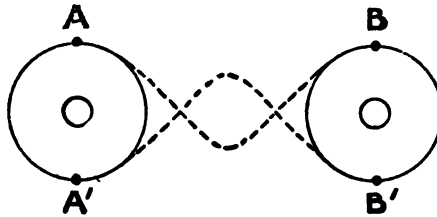


Fig. 2

pose them to be one inch apart or 93,000,000 miles as we please. If we suppose that the small satellites A and B are revolving at the rate of several billion re-

vibrations per second, and that A and B are exactly synchronised, then each body would, by its motion, cause a transverse vibrationary wave, similar in form to a light wave or Beta ether motion. The system A then would, if the distance was just right, have a tendency to cause the ether to transmit a slight impulse to the surface of B, and when B came round to the position B' the operation would be reversed.

It is however plain that if B was moving at exactly the same rate as the ether motion coming from A, it could not possibly receive any impulse. It is thus necessary that A should have a slightly greater velocity than B to produce any effect on the latter. If as supposed above that A and B were exactly synchronised, it is true that they would produce no effect upon one another, but equally true that the slightest difference produced by any external agency whatever in the motion of one, would be transmitted at once to the other. ✓

If the plane of each system was fixed and the ether was absolutely frictionless, we should then have, in this ideal case, absolute conservation of energy. The two systems would be like the coupled driving wheels of a locomotive, between which no a-synchronism could possibly occur and the operation would be continuous. In reality, however, no such simple case as the above is ever likely to occur. Every system must just go on generating its own particular Beta-force indiscriminately in all directions, and each vibration has to take its chances as to whether it will fall on a proximate system or one particular planet or

any other. Wherever it falls it will endeavour to impress its motion on any system it meets. If it is in opposition to the motion of such a system it will produce a slight disturbance which will tend towards synchronism. It is also quite possible that instead of hitting some receptive mass of matter, it may pass out between the stars into illimitable space and thus be lost to our universe for ever.

We thus see that any body, whose internal motion or energy was at a high potential, would impress that motion on any proximate body whose potential was lower. Its highly energetic systems would compel synchronism in the less energetic systems of the other. The mechanical principle by which the effect would be produced, would be very similar to that involved in the interaction of the two tuning forks; and the effective impact of the ether motion through and by which this interaction was produced, would in all cases be of the same order as light.

P. 28. To account for the generation of any visible or invisible light in this way, it is necessary to conceive that the motion of the body which generates it, is of a very high order, a great many billions of revolutions per second. It is obvious then, that to retain even such a small body as a gyron or primitive group in its orbit, requires a considerable amount of force. The usual supposition is, that this restrictive force is supplied either by supposing that the nucleus in or round which the gyron is vibrating is a positive sphere of electricity or a neutral atom, and that the gyron is negatively charged.

In this theory, however, no such conception is necessary. We require only a simple body of sufficient mass, that is to say, composed of enough gyrons; and a smaller body composed also of gyrons and moving at a high velocity, and therefore governed by Principle III. Under Principle III. the moving body furnishes its own attractive influence. Whilst the central body remains on the critical plane of the moving body, no kinetic attraction or repulsion whatever is experienced. The moving body is, however, eternally tending to depart from this position, and under the impact of many synchronic vibrations it might even succeed in momentarily altering the relation; but just as soon as the slightest departure occurs, the kinetic attraction comes into force, and increases proportionately to the increase of velocity. This force added to the constant static force arising from the motion of the components of the central body, then compels the satellite to fall back into its original position. We thus see that any required moderate increase in orbital velocity is quite possible without endangering the constitution of the system.

P. 29. Now every system which we have so far discussed after attaining stability, as even a very primitive group, has a tendency gradually to adjust itself so that its principal components are describing their orbits in the same plane. If we suppose that any atomic system had very nearly arrived at that point, then, under Principle III., definite relations would have been entered into, as between the moving components of the system. Any sudden access of

energy from external sources would cause every single body which had been affected by the energy, to revert towards its original circumstances. It would in fact leave the principal plane of the system and would describe its orbit, still with the same centre, but in a new plane that cut the principal plane of its system at a more or less acute angle, and this angle would depend upon the amount of energy which had been received. If the source of energy was removed, it would gradually be forced back towards the principal plane. Now, in the brief or lengthy period during which it was oblique, the body would generate an ether vibration characteristic of its own motion. Just as soon, however, as the principal plane was approached, the characteristic wave of the part would be merged in the individuality of the system as a whole ; as a distinct effect it would cease to be operative.

Heat and light in any and all of their phases are nothing more or less than ether vibrations.

Whether the heat is produced by chemical action, as in a flame, or in a simple elemental reaction ; whether we touch a substance lightly with a finger, or hit it a blow with a five-ton steam hammer, the heat produced is only an ether motion, which to be classed as heat must have a specific form ; and this specific form can only be given to the ether by an appropriate machine. A small body must be in a violent, and usually abnormal, state of motion. If we require simply red light, we must use a smaller machine ; violet, still smaller ; ultra violet, still smaller, and so on.

In these cases each little body used as a generating

machine requires to perform some cyclical motion, a great many billions of times per second, and whilst performing this extra duty it has still to attend to its ordinary business. It must still keep its place in the atom or molecule to which it belongs. It must still attract the other atoms and molecules in the elemental mass of which it is a part; and it must still fulfil its part in attracting the earth, the sun, and all other celestial bodies.

The difference then between the normal and the abnormal states must be very slight; for it is impossible that the little body concerned could perform all its duties otherwise.

Under our conception no difficulties present themselves. The little body already has the motion that enables it to do its ordinary business, and to enable it to perform its extraordinary duties, at the same time, it only requires to change the direction of its motion an inconceivably small fraction of a degree.

Every atomic molecule has within it the proper machine for generating some known forms of heat or light waves, and each machine only requires a small access of the right form of energy to make it responsive to reasonable requirements.

Here we have the whole mechanical principle of heat and light.

A small body A, in the sun or any other source of light or heat, generates a wave with a certain periodicity. This wave strikes a portion of matter upon the earth, and according to its amplitude penetrates a long or a short way into this matter, until

it meets a body whose periodicity is the same as its own, and whose orbital revolution is synchronised to that of the emitting body. The body thus acted upon leaves the plane of its system and starts generating a similar wave on its own account. If, in the portion of matter, all the systems and their components are a-synchronic, then the vibration is turned aside or deflected by the antagonistic motion it encounters, either entirely outside the matter, or it expends its energy in disturbing and adjusting the internal motion of the unsympathetic systems met with. If a continuous stream of similar vibrations keep on arriving, it is only a question of time until all the small bodies in the mundane mass of matter, which have a similar periodicity to A, have left the plane of their systems and are emitting a similar vibration.

P. 30. Every molecular system, which is sufficiently disturbed by any cause whatever, will then emit a great number of different vibrations. First of all the large systems, then the smaller ones of which they are composed, and then the still smaller, and so on until every complete little system in the whole has separated its individuality from that of the larger system of which it is a part, by slightly orientating its orbit and is separately impressing on the surrounding ether its own characteristic motion.

Obviously, to cause the small systems to respond, a very different form of ether motion is required to that which will affect the large systems. It must be very much more intense and rapid in its vibrations. Just

as a light wave will affect our radiometer, but will leave the wind-mill unaffected, so will still more refined waves affect the small systems and leave the large ones unaffected.

Whatever such disturbance is produced by any cause at any time, will always be produced by it, at all future times, under similar conditions.

Whatever such disturbance is produced by any cause, in any system, will also be produced in all similar systems, under similar conditions, if subjected to its influence.

Finally, whatever such disturbance is produced by any cause in any system, will never be produced in any other system, that is not similar in every detail of its construction.

P. 31. If now we suppose that a molecular system has been disturbed by any means so that all its principal sub-systems are separately impressing, on the surrounding ether, their characteristic Beta motions; the character of these different vibrations will vary very much, if we compare the largest and the smallest type, but they will gradually merge into one another, if we follow the series right through. We should find first, heat waves, grading into red light, and then on down through the spectrum to violet and ultra violet. If our source of energy was strong enough we should even go further. We should disturb even the most primitive of all groups and produce an intensely energetic ether motion of very small amplitude of the X-ray type. But through all this apparent chaos of motion, there would be a

regularity and orderliness, which would be entirely due to the regularity of the constitutional motion and construction of the molecule, the atom, and the primitive atoms and groups concerned ; and the total effect, when analysed by the spectroscope, should undoubtedly give evidence of this regularity.

P. 32. Now, if we suppose that this mixture of different vibrations was to come in contact with some external object, situated feet or miles away from its source, we would naturally expect that its effects would vary according to the constitution of the molecules and atoms of that body. If these were in a rigid and orderly disposition, as in most crystalline bodies, the waves would be slightly deflected, time after time, by the antagonistic ether motions of the inflexible systems encountered ; and the greater part would thus eventually find their way through the body, passing out between its component systems.

If the waves fell obliquely on to a surface, the systems composing which had been induced to take up a rigid and orderly position, either by attrition, or natural surface tension, they would be deflected by the antagonistic ether motions encountered.

If the waves fell directly on to some object, whose constituent systems were mobile and flexible and sufficiently heterogeneous to be able to respond to the periodicity of all the incident types, then if these latter were representative of all the principal common types, the resultant motion would convey the impression of white light ; if the systems were wholly a-synchronic, black ; and partially, different colour-

ations, and in each case the vibrations which were not productive of synchronised orbital motion, would be used up in creating atomic and molecular disturbance, which would in their turn generate secondary vibrations of the order of heat.

Any such heat waves generated at the surface of a mass of matter would be propagated radially, and would thus be conducted from system to system throughout the mass.

Speaking generally, those elements whose systems were not too rigid by reason of their complexity, on the one hand, or the mass of their principal groups on the other, would be most easily subjected to such an influence; they would, in fact, be the best conductors of heat.

All those elements, then, which represent the mean of these two extremes and which are placed about the centre of Table VIII., in the middle of the Lithium and Beryllium groups should thus be, theoretically, the best heat conductors.

P. 33. If now we supposed that a number of dissimilar elemental masses were placed in such conditions that they were at the absolute zero of temperature, and in the dark; being then removed from nearly all possible contact with outside energy, each system would rapidly take up the position which represented, for it, the greatest attainable stability, consistent with its constitutional internal motion. In each case the component groups would approach, and in most, if not all, cases absolutely lie on the principal plane of their several systems. If now we

instantly brought all these masses out into the ordinary daylight, in a short time expansion would take place, upon the various subsidiary groups leaving their principal planes.

Even at the ordinary diurnal temperature some of the systems would become so far orientated that their Alpha attraction would be superseded by the repulsion of the Beta-force, as between any two similar systems. The elements or masses in which this occurred would then pass into the gaseous state. Add more heat to the remaining elements and further expansion and eventually repulsion would take place between the component systems of them all.

The gradational physical changes taking place between absolute zero and a very high temperature, would thus be nearly similar in form for every atomic or molecular system ; but since the systems comprising any elemental mass, are differently constituted to those which comprise any other mass, the physical changes would occur at different temperatures.

P. 34. In most systems, if left entirely undisturbed by outside energy, the tendency of the component groups would be always towards a slight contraction of the orbital area, and this would apply to all temperatures lying between absolute zero and the highest attainable. This slight contraction would be an expression of the universal tendency towards disintegration, provided the bodies are not supplied with sufficient energy from external sources. If now a small amount of energy is given to these components

they must widen the area of their orbits before leaving the plane of the system. Between narrow limits then, every system must have a characteristic orbital elasticity. To bring a component from the lower limit of orbital elasticity to the higher, a certain definite amount of energy must be absorbed ; but the system as a whole will give no external evidence of this absorption, the temperature, or in other words, the emitted heat of the elemental mass will not increase. This absorptive capacity of the system is known as its "Latent Heat Receptivity." The temperature at which the orbits of the components are so far orientated that similar systems begin to mutually repel one another, is known as the "Boiling Point." It is simply the gradation line between the liquid and the gaseous state. The gradation line between the liquid and the solid state would thus represent a further reduction in the orbital orientation. At this point the mean, molecular attraction is just balanced by the repulsion of some of the component groups. The orbital elasticity of any molecular system will determine its absorptive capacity for latent energy. The stronger the central body and the more mobile the satellites the greater will be the elasticity. The highest limit of orbital elasticity will then be reached by a system composed of group 16 in its most active state and group 1, the smallest, and therefore the most mobile atomic system.

The nearest we can come to this system is H_2O , and this explains why the latent heat of steam is greater than that of any other known vapour.

P. 35. Intense pressure will cause the molecular systems of a gas to compulsorily seek their principal planes. They will thus rapidly give up energy, and if at the same time a very low temperature is also maintained, all the conditions necessary for causing the gas to assume the physical conditions of a liquid will be complied with. In reversing this process, as the gas is being expanded the components of the various systems within it will absorb all the available surplus energy either going to or coming from adjacent systems, with the result that whatever components in these adjacent systems, had been up to that time orientated, will swing back to their principal planes and will cease to generate heat waves, provided the difference in potential is not too great. The adjacent bodies, upon ceasing to generate heat waves, will be appreciably cold, to a greater or less extent.

P. 36. If a number of similar systems are energised so that they pass into the gaseous state, they then repel one another and also energetically repel any rigid body brought into contact with them, as for instance, the retaining walls of a receptacle in which the gas is held. There is no actual dynamic impact of one system upon another, such a thing is impossible whilst the systems are moving at as high a velocity as is the case when in the gaseous state. The action is just a simple dynamic effect of vibrationally moving ether, similar to the impact of light.

If now an aggregate of systems dissimilar to those of the gas, is introduced into the receptacle containing

the latter, this aggregate as a whole is subjected to the same repulsive treatment. But if its temperature and consequent mobility is right, and if some of its molecular components are capable of synchronising with the vibrations emanating from the gaseous systems, then these are swung round and cease to be operative in producing repulsion as between the dissimilar systems. The ordinary molecular attraction between the remaining components is thus allowed to take place. It is obvious that this action might also take place between the systems of the gas and those of the retaining walls of the receptacle. In either case, a chemical¹ or compound molecular system is formed, which must from the conditions, be a system, composed of bodies brought together by the relation of the kinetic energy of the more volatile bodies and the static agency of the others.

P. 37. This is as far as it is necessary to go into the mechanical principle of the action of all Beta forces.

We have, as a result of the following out of the conception, a great number of transverse vibratory types, which are however graded continuously from the smallest to the largest, through the distinctive types that are known to our senses.

We have as distinctive types—

The X-rays.
Ultra violet light.
Violet light.
Red light.
Heat waves.

And we may express the principal distinctive qualities of the series by saying that—

The mechanical effects which may be produced by any Beta-wave depends on its amplitude and intensity. With respect to the whole series, the amplitude is inversely proportional to the intensity, and consequently also to the penetrative power of any type.

They are all generated by bodies revolving within systems of definite and constant form.

The energy dissipated is carried by the ether in the form of a simple transverse vibration, which has characteristics which are typical of the system that caused it.

Energy can only be reproduced in any particular form by synchronised units in a body which have already been subjected to a practically similar influence.

P. 38. To sum up then, we see that all small bodies have had in the beginning a certain amount of potential energy with respect to some similar body. As a result of the Alpha-force they have assumed orbital relations to one another and have then proceeded to dissipate their energy in the form of Beta waves. They would very soon dissipate all their original energy but for the fact that they are constantly receiving energy from outside sources, in a very nearly similar form to that in which they are themselves constantly emitting it. The present motion then of any system is, firstly, dependent on the original potential energy of its components. This energy established the size of the system and its orbital

range; in other words, these were determined by the initial position of the components in space. Secondly, the present motion is due to the energy which is received from other identical systems, themselves also the products of position, space, and time.

By means of the Beta-waves a body whose systems are in very rapid motion is continuously transmitting a portion of that motion to other contiguous and less energetic bodies. The energy of the universe is thus levelled up or transmitted between bodies, exactly as heat is transmitted from a portion of a mass which is hot, to any other portion which is cold.

The entire energy thus sent back and forth is, and has been, derived from change of position, and no such change of position from a high energy of position to a lower form of the same, is possible without producing some form of ether wave.

We thus see that in coming from a position of infinite dispersion, any body like the sun or our earth has transformed an enormous amount of energy from the potential form into that of the Beta-wave, and this energy has, in that form, been distributed to the uttermost parts of the universe.

If every ray of light and heat, thus generated, was received by some body, there would be no loss, there would be absolute conservation of energy. But is it possible to conceive that this is the case? Must there not be a small proportion of the total energy of the universe continuously radiated out into space? Even if one light wave so passes out every year, it is a loss, unless continuously refracted and so returned, or

unless it is itself the cause of regenerative processes, of which at present we know nothing.

Finally, then, we may say, that the constitution of the universe represents a balance that nature itself has struck between two great forces. One that tends towards consolidation and the other towards dispersion, and these two are continuously fighting against one another.

The first of these is the Alpha-force, in all its phases.

The second is the Beta-force, in all its phases.

CHAPTER VI.

ELECTRICITY AND MAGNETISM.

“Positive electricity as apart from an atom does not seem to exist. It never seems to fly free as the corpuscle does. Its nature is, to-day, a mystery.”—“The New Knowledge,” p.p. 189. Prof. R. K. Duncan, Professor of Chemistry in Washington and Jefferson College, London, 1906.

“Current electricity is due to nothing but these corpuscles in motion.”—“The New Knowledge,”——p.p. 187.

In the following pages an attempt is made to eliminate the mystery, by calling on the moving corpuscle to explain both positive and negative electricity.

CHAPTER VI.

ELECTRICITY AND MAGNETISM.

P. 39. The Greek philosopher, Thales of Miletus (600 B.C.), although not the discoverer, was probably the first to place on record his knowledge of the fact that, when rubbed, amber developed a curious property. It became possessed of the power to attract small particles such as straw, dried leaves, etc. The fact was also noticed by other later Greek philosophers, but no practical development was attempted until about the year A.D. 1565, when Dr. Gilbert of Colchester commenced to experiment on various substances, having in view the elucidation of this strange property.

His results were sufficiently successful to excite the interest of many great minds and lead to a long series of remarkable investigations and discoveries, which have led up to and made possible the science of electricity as it exists to-day.

About the year A.D. 1747, Sir William Watson first made use of the terms Positive and Negative electricity; terms which have survived even to the present day.

Through all these years of development and

progress, there has existed at no time any very clear mental conception of the real nature of the entity which was called electricity. At one time it was a fire, at another a fluid, and at another something else ; but through all these variations in opinion there was one conclusion that seemed to be firmly established—electricity was a distinct entity, something that was different from matter and also from force. Something that existed in two distinct forms, which it was possible to separate, and to cause to do work when coming together again, or whilst entirely separated.

It took many years of work and development to instil into the scientific mind a slight doubt as to the validity of this view ; and if we look up the proceedings of any scientific society that deals with this subject, we will see that it is still an open question. There is no certainty either one way or the other, for or against the view that electricity is a distinct and separate entity, different from ordinary matter and also from force.

The scientific mind is in fact as yet afraid to commit itself entirely to either the view that electricity is a form of motion, just as is heat, or a material thing, as is any form of matter. At best, there seems to be offered a comparatively clear solution of but half the problem, and this is in respect of the electron—the unit negative charge of electricity. This seems to be accepted and explainable as a mode of motion, an ether motion in fact, pure and simple.

But what can we think of the “Unit Positive

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Electrical Charge," or "Sphere of Electricity," or of the expressions "Carrying a Positive Charge" or "Carrying a Negative Charge." It seems hard to associate these terms with any other mental picture or impression than that which is connected with materiality.

We may admit that the negative unit electrical charge has a more or less clear definition in the electron; but we can make no such admission in respect to the unit positive charge, or positive electron, which the highest authorities admit has as yet never been proved to exist. Yet the possibility of its existence is not seriously questioned. It is a necessity to the electrical conception, and therefore must exist, seems to be the only reasoning that is advanced in support of its possible existence.

And yet perhaps the same person who will off-hand make use of any or all of these indefinite and misleading terms, may be the very personification of accuracy in other respects. It is in fact because of his wish to be accurate, or at least his dread of being inaccurate, that he will hesitate to commit himself to any view which is not absolutely proved, either by experiment, or strict logical or mathematical reasoning. The very essence of reason however is, or should be, consistency; and if he puts forward the point that he relies on reason, mathematical or otherwise, and that until such is produced he cannot alter his mind, he in so saying undermines his whole position.

It is undoubtedly possible to prove that there is such a thing as a negative corpuscle or electron, and

all honour and recognition must be freely given to the men, who, by their untiring efforts and ingenuity, have made its existence possible of demonstration. This part of the problem has received all the proof that any reasonable man can desire. It is, however, in the other half of the problem that conclusive arguments seem to be lacking. That because it can be irrefutably shown that there is a negative charge, there *must* be an accompanying positive charge,* is the reasoning that is referred to; and it is claimed that it is not only unnecessary, but is inconsistent with the methods that are usually followed.

It is true that in respect to light and heat, we say there must be an ether, because we cannot explain the action of either without that ether, but the cases are very different.

The same ether may be used to explain matter and the inner workings and being of the electron, but when we try to define the positive electron, its action on the negative, and the relation of both to the ether, we seem to experience difficulty at once.

*."We should expect the negative charge on our corpuscle to follow the pattern of all other negative charges and to have associated with it, too, an equal charge of positive electricity."
—Prof. R. K. Duncan,—“The New Knowledge,” p. 153.

“As the atoms of the elements in their normal state are electrically neutral, the atoms must, along with the corpuscles, contain positive electricity. The form in which this positive electricity occurs in the atom is at present a matter about which we have very little information.”—Prof. J. J. Thompson, “The Corpuscular Theory of Matter,” p. 103.

If we must assume that ether exists, to explain the electron and different forms of matter and energy, it seems to be entirely logical to seek for an explanation of positive electricity also in the same premises. It is claimed that we can only do so by going more carefully into the electronic idea itself; and by the elimination of old ideas, which are not consistent with modern discoveries and advance. If we accept the view that the electron represents some form of ether disturbance and that the influence by means of which it is acted upon by the positive charge, also represents some form of ether disturbance, we are still left without any clear idea of what the positive charge, or sphere may be. It seems to be a distinct and separate entity, about which we know nothing, and its continued acceptance seems to make further advance impossible.

Accepting the ether as a necessity and the definition of the electron as an ether motion of some sort, the consideration of modern ideas then supplies us with a very curious reply to the question—what is electricity? It is two-thirds a mode of motion and one-third material. Two-thirds of it is postulated and one-third is logically demonstrated. Would any one accept such a view in respect to light or heat? If any one advanced such a view in respect to these, would not his argument at once be buried under an avalanche of adverse reasoning and criticism? His view would be unacceptable because of its want of definition. Then why should any similar degree of indefiniteness be countenanced with respect to any

other science. The man who can accept the one should reasonably accept the other.

If the electrical question is answered in the manner indicated, is it not because of the difficulty experienced in breaking away from old ideas? It is difficult to make the leap which will carry one over to some new and more modern view. Originality is lacking, and because others do the same, a view is accepted that was put forward one hundred and sixty years ago by a man (Sir William Watson) who was possessed of originality and gave it expression in the idea of positive and negative electricity. It must be expressly stated that no disparagement of this conception is intended; that it has lasted so long is sufficient and irrefutable evidence of its value. With the evidence which was then at his disposal, Sir William Watson said all that at that time could be upheld by facts. If he had gone as far as it is possible to go now, facts would not have upheld him, and whilst he would have still displayed originality, he possibly would not have given expression to an idea that has influenced progressive thought for one hundred and sixty years.

If the idea of positive and negative electricity was once acceptable and now is not, we may well ask what new discovery or new law has brought about this change? A conception which has held an honoured place in electrical science for so many years cannot lightly be deposed. It requires something new to take its place, something which from the nature of the requirements must be fundamental and basic,

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something about the existence of which there is or can be no doubt. We have in the gyron the very idea that the circumstances make necessary. If we think only of electrical science, we may say that in the corpuscle or the electron we have the required fact. The idea of the gyron as distinct from the electron need only be introduced if we desire to show the relationship of electrical science to all other branches. In any case, whichever conception we accept, to make the corpuscle or the gyron account for electricity without the aid of the positive sphere, or without any such mysterious conceptions as positive and negative electricity, we must accept the views already outlined as to the constitutional motions and tectonic detail of the molecule, atom, and primitive groups.

It seems hard to imagine that such a minute product of man's imagination and ingenuity as the electron or gyron may be made accountable for such vast effects as we know of in practical electrical science.

The difficulty seems to be multiplied when we throw away those one time useful conceptions, which are now but fruitful sources of mental enervation, those products of Sir William Watson's originality and insight, which are known as positive and negative electricity or charges.

We may, however, derive courage from a general consideration of the progress of our age. Twenty years ago, a man who upheld divisibility as a necessary attribute of the atom, would have been

classed as a crank. If he reported that he had discovered how to make one element from the disintegration products of another, who would have believed him? If he had talked of corpuscles and electrons in the glib manner of to-day, he might have gained a reputation for brilliancy of imagination, but undoubtedly he would have lost it as far as his sanity was concerned. Yet to-day the time-honoured theory of the indivisibility of the atom is dead, transmutation has been accomplished and the electron reigns supreme. Who can then say with certainty that on the scrap-heap, whither goes every superseded scientific conception, a place is not even now marked out for the electrical theory, beside that already occupied by phlogiston, atomic indivisibility, and such like great ideas of the past?

If there is a possibility of this fate befalling the electrical theory, we may as well face the issue at once. We must, however, in bringing about its downfall put up in its place some entity that is capable of filling such an important place, and to be a real advance it must fill that place and as near as possible all others. We must then absolutely cut loose from all preconceived ideas. We must burn not one ship or two but the whole fleet. We must believe that—

There is no Positive Electricity.

There is no Negative Electricity.

There is no such thing as Electricity.

When we have succeeded in making this mental effort and have thereby opened our minds for the

reception of new ideas, we will perhaps be able to realise the true explanation of all the facts that have been classed as electrical.

In reality, however, it is quite easy for us to make this effort. All that it is necessary for us to do is to freely admit that whilst the old explanations of the facts appear to be sound, there may yet be other explanations, quite as sound and at the same time less mysterious, that will apply to electrical facts and at the same time perhaps illuminate other dark corners of the general cosmogonical scheme.

To make the issue specific we may say that we have to make up our minds to answer the question. Is electricity a material thing having mysterious attributes that we cannot explain? or is it simply a mode of motion such as, in a general way, we know light or heat to be? In denying the separate existence of electricity either in positive, negative, or neutral form, we cover the first part of the question and are left with the other possibility alone. Electricity then is a mode of motion. The further question then at once arises—motion of what? We have the answer ready again. It is simply motion of the ether. Not indefinite or indeterminate motion in the ether, but absolute motion of a certain volume of the ether which has already been subjected to definition and the compulsion of definite laws.

P. 40. All that has been written up to the present was necessary to enable us to gain a clear conception of the point at which we have now arrived. Up to the present there was no place at which the idea,

conveyed by the term electricity, could have been of any use to us; but we come now to a vast array of facts which, though they may be easily explained without the use of the word electricity, yet require for the present some distinctive name to differentiate them from all others. But whilst it may be considered desirable to array these facts under the title "Electricity and Magnetism," it must be clearly understood that the desirability is determined by purely utilitarian considerations. All the facts that can logically come under this heading, do in reality form an extension of the general scheme which we have so far followed. They form in themselves a simple corollary of all that has gone before. In introducing the term electricity we introduce no new force, nor have we to develop a single new principle. We have already the necessary force at our command, and we have already the fundamental laws wherewith to direct its application.

P. 41. To make the point at which we have now arrived perfectly clear, we will rapidly review the situation.

We have supposed all matter to be made up of little planetary systems composed in their last analysis of gyrons, which are themselves simply ether in an intensely energetic state of motion. Each of these bodies or systems have been supposed to resemble a small disc in a state of rapid rotation about a central axis, and each of them as such is capable of giving rise to three entirely distinct types of ether motion which we have called—

- (1) The Alpha-force or ether motion, generated by the lateral faces.
- (2) The Beta-force or ether motion, generated by the periphery.
- (3) The Gamma-force or ether motion, generated by the system when in a state of translative motion from place to place.

The Alpha-and Beta-forces, as so far developed, may be considered as the results of restricted motion. That is to say, the bodies concerned can only generate these forces when their motion is restricted to a rotary form.

The third, or Gamma-force, becomes of importance only when the body concerned is unrestricted as to its motion, or at most enduring but temporary restriction.

We may say generally, of the three forces, that whilst the interaction of the Alpha-and Beta-force is necessary to sustain the universe, this interaction would have been impossible but for the Gamma-force.

No two small bodies moving at a velocity of the order, which it is necessary to imagine to explain light, could ever have assumed orbital relations but for the Gamma-force. No system could ever then have been formed capable of generating the Beta-force in all its phases, and in this case the Alpha-force of the gyron would have long ago caused universal consolidation.

In the development of the Alpha-and Beta-forces, we have seen that the various systems must be considered as made up of definite and constant numbers

of gyrons. If this be so, it must also be necessary to admit, that if by any means we were to take away even one gyron from any subsidiary system, that is used in the construction, of say the hydrogen atom, the whole system would become unbalanced and would fall to pieces. There is, however, probably no natural force existing at present on earth that would be equal to such a task, in respect to at least the existing primitive atoms.

The contention is clear and perfectly defined, that whatever number of units go to make up an atom of any element, that number must remain unless we reproduce the conditions under which the synthesis took place, or so alter the present conditions that natural devolutionary processes may take effect.

Given, then, these practically constant systems we have a workable basis for our argument, that they are capable of generating constant forces, as long as their constitutional motion is maintained.

We have then as different forms of the Alpha-force generated by different systems, gravity, intra-atomic cohesion, intra-molecular cohesion, and mass cohesion, the last being practically the sum of all the others.

We have as different forms of the Beta-force, X-rays, light and heat, with their intermediate types.

These represent all the important forces that we can derive from restricted or constant motion.

P. 42. The Gamma-force which we have now to consider may be defined as the effect of practically unrestricted motion. It is the ether motion generated by all bodies, when moving at a high velocity either

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in temporary orbits or in purely translative motion from one system to another.

It is a simple mechanical principle that the energy of any moving body may be calculated, if we know the mass of the body and the velocity at which it is moving. The wellknown formula $\frac{mv^2}{2}$ where m is the mass and v the velocity, shows at once that whilst the effects of mass remain constant the effects of the velocity may be increased almost indefinitely. Where the bodies to be considered are very small, it thus becomes plain that the velocity is by far the most important factor. The bodies which are capable of attaining to the highest order of velocity will thus also be capable of developing the most intense Gamma-force.

Whilst then we must allow that all the bodies which we have so far considered are capable of developing the Gamma-force, the ones which are pre-eminently suitable for its highest development are the smallest possible bodies, namely the gyrons. Their size alone enables them to attain a greater velocity than any other body if subjected to a given force, and furthermore, what is very important, they can do it in a shorter time. The smallness of their mass is also important in another respect, namely, that it permits them to permeate all matter.

We have seen that all matter may be considered as made up of systems of small moving bodies. If we think of one of these systems as being built on exactly the same principle as our solar system we can easily understand, that even in the case of a primitive atom, the inter-planetary space which is

unoccupied, is many times greater than the space which is occupied by the bodies composing the system. Again outside the system, between it and the next, is a still greater space. The volume of space which is taken up by the interstices of a portion of matter is very much greater than that which is occupied by the bodies which compose that matter.

If now we suppose that a free gyron, one that owes allegiance to no system, and is free to come and go as it pleases, is brought close to a mass of matter, which we will consider for the moment as consisting solely of its integral systems and sub-systems, we are able to say at once what will happen. The gyron will be forcibly attracted towards the matter and will pursue a comet-like course through the comparatively vast inter-planetary spaces within that matter. If its velocity is great, as it naturally would be, should its path at any time be directed momentarily towards any body, Principle II. provides that it will at once repel that body and will be thus itself deflected.*

* It is thus physically impossible for a rapidly moving gyron to collide with an atom and to in this way generate heat. The gyron, and this applies equally to the corpuscle or electron, cannot carry heat, it may only receive intense translative motion from systems which have been so affected that they are emitting the ether waves which are known as heat. Upon the gyron coming within the range of another system, this motion may then be transmitted to it by the action of Principle II., but to gain a clear idea of the conduction or generation of heat or electricity by the gyron, we must absolutely abandon the idea of impact on either an atomic system or any other gyron as presenting in the slightest degree a feasible possibility.

Furthermore, this operation will be continuously recurrent, until the greater part of the kinetic energy of the gyron is used up, and at last somewhere about the centre of mass of the body, the gyron will be overcome by some great central atomic sun, and it will assume orbital relations to that sun, very similar to those of the asteroids in our own planetary system.

But these relations are only temporary. If any great ether vibration was to find its way to this system, such as for instance a ray of ultra violet light, whilst it might only be able to slightly increase the orbital motion of any of the groups belonging to the system, it might be quite able to impart sufficient energy to the solitary gyron to drive it completely out of the system, in which it had assumed temporary relations, and under certain conditions even completely out of the mass of matter itself.

Now, if instead of one free gyron, we have millions of such bodies, it is plain that they will behave in a very nearly similar manner to the single gyron, and we thus see that every portion of matter as soon as formed, will tend to occlude a vast number of free and perfectly mobile bodies within its unoccupied spaces. It is obvious also that the number of these occluded gyrans will depend on the constitution of the competent systems of the matter.

We thus have a new and very important addition to each of the systems which we have been studying, namely the free gyrans, which according to its constitution it is capable of occluding. The most im-

portant quality of these occluded gyrons is, as far as we are concerned at present, their mobility, that is to say the practically unrestricted motion of which they are capable. Practically all the forms of the Beta-force are capable of effecting these free gyrons, either by direct impact, or by so altering the orbital relations of the restricted bodies in a system, that the mobile bodies are disturbed in whatever position of temporary stability they may have taken up. The effect that any external force will produce on the free gyrons in any system, is thus largely influenced by the effect which that force will produce on the system itself. A system which is much influenced by say heat, is just the system whose free gyrons will also be much influenced by the same force. Conversely, if the systems in a body are so constituted that heat and light produce but comparatively small effects, then the free gyrons in that body will not be disturbed to such an extent as in the other.

If a system is made up of a large number of small bodies in a complex state of motion, as for instance, the platinum atom, the free gyrons will be with difficulty dislodged therefrom ; because at whatever point they may happen to be at any instant, there will be a small body near them, ready to exert a retaining influence upon them. On the other hand, if the component bodies are very large, they will exercise a similar pull by reason of their mass, working in conjunction with Principle II.

Where the component bodies are not so large there will be less pull. Selenium with very large groups

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[$48+2(16)$] and copper with medium groups will illustrate these two cases. Again comparing the copper atom [$48+2(7)$] with the platinum atom [$144+8(6)$], there can be little doubt as to which will have the greatest retentive powers of the three; copper will most readily part with its free gyrons, or pass them on to other systems. It will in fact be the best conductor of the three.

For the same reason the elements situated about the centre of Table VIII., as representing the mean of the two extremes of retentivity and the limit of component mobility, will be the best conductors of the free gyrons.

P. 43. Any atomic system which is in the gaseous state, has, in coming to that state, expelled almost all its free gyrons. At normal temperature the component groups of a gas are continuously being acted upon by the radiated heat waves from surrounding bodies, and are kept in such a disturbed condition that they continuously oppose the entry into the system of any free gyrons. This effect is entirely due to the impact upon the free gyrons of the Beta-waves generated by the components of each of the systems. To cause such systems to admit extra gyrons, the latter must be as it were, shot into them at a high velocity, such as would be reached on coming from a body with a still higher temperature. Even when within such a system the position of the free gyron can be but temporary, it will soon be ejected, particularly if subjected to the attractive influence of some other more receptive matter outside.

P. 44. We may now divide all elements into two great classes, the general characteristics of which may be broadly stated as follows—

- (1) Those elements, the systems of which by reason of their rigidity, complexity, or the mass of their components, energetically retain free gyrons to the full limit of their capacity and thus oppose the entry of others. These are non-conductors.
- (2) Those elements, the systems of which by reason of the mobility, simplicity, and mediocre mass of the components, readily part with some of their occluded gyrons and are equally ready to acquire a like number. These are conductors.

The application of moderate energy, whether due to any form of Beta-force or otherwise, to the free gyrons in the two classes, will have very different results. In the first class the rapidity of their motion, in whatever orbits they may be revolving at the time, will be increased.

In the second class they will be caused to leave these orbits and pass on to the next system; each one so transferred, driving out another from the system to which it is translated, by reason of the energy of its approach, operating under Principle II.

Any body whose systems are in a rigid state of motion, such as in crystalline structure, will thus not transmit free gyron motion from one system to another by means of direct translation. The velocity of rotation of the free gyrons within the systems may

be increased, and by this means may be productive of motion in adjacent systems, under Principle IV., but this process will be infinitely less effective than in the case of pure translation.

The effects produced in the two cases are of a very different nature and are known, in the first case, as statical, and in the second, as dynamical electricity.

P. 45. The elementary propositions or axioms which govern all static effects are—

- (1) Principle II. and Principle IV.
- (2) Of two systems, the one which is in the most energetic state of motion impresses its characteristic energy on the other.
- (3) If a system is subjected to any force whatever, it will tend to take up the position of least resistance to that force.
- (4) If the free gyrons within a system are by any means acted upon so that they have a tendency to leave that system in any direction, they tend to pull the system as a whole in that direction. Principle II.
- (5) The lateral faces of a system generate effective ether motions which may be represented by right and left handed helices or spirals, which are very nearly complementary to one another. Two systems then which are revolving in parallel planes about the same axis will attract one another, if revolving in the same direction, and repel one another, if revolving in opposite directions. This effect has already been discussed.

When a number of free gyrons are revolving within or around a system, they tend to move in the same plane and in the same direction as the constant components of the system.

If the system is subjected to any external force the free gyrons usually feel it first and may thus be effected almost independently of the system. In any case any effect that is produced on the gyrons is communicated to a lesser extent to the system, and any effect produced on the system as a whole, has also an instantaneous effect on the free gyrons.

Since the free gyrons within any system will all be more or less influenced by external energy, and generally at practically the same instant, in static effects, they may be considered as systems of free gyrons.

Only a few examples are necessary to indicate the methods that may be employed in discussing every electrical effect of which we know. The general intention is, not to discuss the whole range of electrical science, but to show that the idea of positive and negative electricity is entirely unnecessary; that it became so upon the discovery of the corpuscle, and that it is still more unnecessary if we use the gyron. So much is this the case that it becomes very difficult to find any place at all for the old notation, for even if we generalize certain forms of motion under different empirical terms, analogous to positive and negative electricity; we still cannot use these terms, because they convey an entirely erroneous impression.

The few examples which will be given, one in statical electricity and three in dynamical, are chosen because they are representative, and once understood they represent the key to all others.

We will first consider an elementary statical effect.

P. 46. To produce an appreciable static effect by friction, we require to operate with elements or substances in which the molecular systems are either in a constrained and rigid position as in glass, or are composed of very large groups, as in sulphur. In either case the free gyrons are retained forcibly within their respective systems and may thus receive a large amount of additional energy without breaking loose from their temporary restraint. Also, whatever motion they may receive is not necessarily transmitted at once to other systems, as would be the case if an element were used whose systems were of a more mobile construction. Any motion then given to the free gyrons may thus be isolated more or less in one part of the substance operated upon. Whatever two non-conductors we choose to operate with, the effect which will be produced in either surface will depend entirely on the relative rigidity of the systems in the two. Whichever is composed of the most rigid and yet energetic molecules will impress its individuality on the other.

Now let us rub a glass rod, A, with silk, B, the action which takes place is as follows—

The friction causes a disturbance to take place amongst the molecular components of the systems on the surface of both bodies. This disturbance at

once becomes apparent as emitted heat, and the surface systems become unsettled in whatever position they may have originally existed. They become disturbed both internally and as regards their external relations to proximate systems. A slight readjustment of both the systems and their occluded free gyrons then becomes possible, and this adjustment takes place first at the surface where the action of the rubbing is most felt, but continues back into the mass of matter to an extent dependent upon its constitution.

The free gyrons in each system on the surface of A, more or less effect the systems immediately round about, and the action produces, as near as possible, synchronism, in both those that are parallel and in those systems whose revolutions are in or nearly in the same plane. In place then of a number of free gyron systems rotating anyhow in different planes, we have a great number of such systems rotating either in the same plane or in planes that are parallel, and the combined effect of all the systems so rotating is appreciable at the surface.

Now if any mass of matter, C, is brought up gradually towards this surface, this combined effect causes a similar motion in its surface systems (Ax. 2). That is to say, it compels all the free gyron systems in the surface of C to orientate the plane of their orbits (Ax. 3), so that they also become parallel to one another, and also to those in A. We then have a great number of gyrons revolving in the same direction in parallel planes. A moment's consideration

will show us that these free gyron systems are individually generating right (R motion), and left, (L motion), helicoidal ether motions, and that in consequence they will be attracted towards each other, (Ax. 5). They will therefore endeavour to pull their respective atomic and molecular systems after them, (Ax. 4), thus producing a resultant tendency of A towards C.

Now if we suppose that C is a pith ball suspended by a silk thread, whatever internal motion is conveyed to C will be confined to it alone and will not be transmitted to whatever support is used. Under these conditions C may be called an isolated body; the silk thread, on account of its internal rigidity, being an isolator. Under these conditions, C will behave as above indicated, but if we approach it still closer to A, until in fact it touches, then a new action takes place. The free gyron systems in C are not absolutely synchronised with those in A, and they are not rigid enough to persevere in their respective courses, as they would do at a distance, when subjected to the generalised effect of A's systems.

They now become subjected, owing to their a-synchronism, to the Gamma-force of the individual gyrans in A's systems, with the result that they are forcibly repelled individually and caused to orientate their planes and to revolve in an opposite direction. They as systems are then repelled, and will thus compel C to reverse the original direction of its motion.

If now we touch A with the finger or any conductor

connected to the earth, or in other words any body which is not fitted by its internal construction to act as an isolator, A momentarily endeavours to affect all the free gyrons in the matter presented to it, in the same manner as it originally did to C. In the case supposed, however, it is entirely unequal to the task. Instead, the systems in A keep on receiving various impulses from the systems in the finger, a few concordant, the majority discordant, to its own regular motion, and eventually it has to give in, its motion ceases to be synchronised and regular, and is consequently dissipated.*

We may express this whole operation in a few lines, thus—

By rubbing A with B, R and L motions are set up by their contiguous surfaces. Upon approaching an isolated pith ball C towards A, the same effect is induced, and they consequently attract one another. Upon contact of C with A the free gyrons in the former are subjected to the Gamma-force of the more energetic gyrons in A, and under Principle II. are

*The principle of the gold leaf electroscope is easily understood from a consideration of the pith ball experiment. Regular, orbital free gyron motion is induced in the insulated brass plate. If the gold leaf once touches this plate, the Gamma-force of the components of the energised systems eventually causes repulsion between the two bodies. Any external influence, such as the impact of free gyrons, or antagonistic free gyron motion, may cause the disturbance of the regularity of the motion in the plate, and thus the fall of the gold leaf. A system as energetic as an α -particle or any radium product, will naturally at once disturb the motion.

caused to rotate in an opposite direction, and C is consequently repelled. Upon connecting A with any large body such as the earth, its isolated motion is dissipated.

Modifications of the arguments used in this explanation will be found to explain every effect that comes under the heading of static electricity.

The general principle of all static effects is this. We may induce rigid motion in an isolator. We may then use this rigid and practically constant motion to compel motion in either other isolators, or in other dissipators, (as in the Leyden jar). We may thus so arrange matters that the effects produced will be sufficiently intense to force some of the free gyrons out of a body subjected to their influence, at a velocity which will be great enough to produce disruption and other effects in contiguous bodies upon which they fall ; or they may generate momentarily Beta-waves of the same form as ordinary light, owing to their retention for a short time of their original orbital motion.

P. 47. We must now pass on to the much more important effects which come under the heading of Dynamical Electricity.

In a great number of cases there is no absolute separation of the two classes. An effect may be produced by the interaction of both classes of systematic motion, the principal or compelling force being due however to translative motion.

Once a free gyron has been induced to leave its temporary orbit to follow a straight path, its capacity

for doing external work is very much increased. Whilst it is subjected to its temporary restraint, the greater part of its energy is wasted upon the bodies which compose the system that has held it in restraint. Once put in a state of translative motion from system to system, hardly even stopping at any one encountered, the available energy of the gyron becomes very greatly increased. Any influence that is great enough to cause a gyron to leave its temporary orbit, also ensures that its subsequent progression will be at a velocity which will be instantly raised to a very high order.

Before entering upon the discussion of dynamical effects it might be well to reduce our ideas of conductors and non-conductors to a more general statement. All solids have a certain absorptive capacity for free gyrons. Normally, any gyron thus absorbed has its motion altered to conform as nearly as possible to that of the integral molecular systems of the solid. Extraneous force effects these systems according to their rigidity and the occluded gyrons in proportion to the rigidity and retentivity of the system. The motion in any body thus becomes the resultant of two forces, that exercised by the body and that exercised by external energy. A conductor thus becomes a body in which the motion of a free gyron is determined principally by the external force to which it is subjected. A non-conductor is a body in which the motions of a free gyron is determined principally by the internal force to which it is subjected. A still further generalised idea of a conductor is that,

energetic motion at any point in contact with the conductor is almost instantly dissipated throughout its systems. Whether this result is brought about by induced motion under Principle II. or otherwise is immaterial. Abnormal energy is dissipated as a result of its internal construction. It may thus be termed a "Dissipator."

A non-conductor is a body whose internal motion is so rigid that external motion has little effect upon it. The internal motion of a point in contact is thus not transmitted or dissipated through such a body. It is in fact isolated within that point. Such a body may thus be termed an "Isolator."

We shall now consider a few fundamental dynamical effects, and we shall take as being the most typical the following examples—

The Simple Cell.

The Electro-Magnet.

Induction.

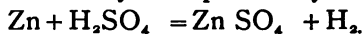
The essence of the principle of dynamical electricity is that translative motion must be set up in the free gyrons existing within a body. Whether this is done by chemical, thermal, magnetic or any other cause, the general principle is the same. One or more gyrons are caused to leave one system and pass on to another, and the general aim in all dynamical operations is to arrange matters so that each system at one end of a dissipator has more gyrons than it actually wants, whilst at the other end, the systems have less than their actual capacity. Any continuous generative operation consists essentially then, in

crowding in gyrons at one end and taking them away at the other.

In considering the effects produced by a large number of moving gyrons whether influenced dynamically or statically, they may be considered as a generalisation of the total influences of the units, as long as the velocity of the latter is great enough and the distance between them is small. Thus a large number of similar small circular ether motions, whether absolutely concentric or not, become roughly generalised into a series of large circular motions, after a certain distance has been gone over. This applies to the ether motion generated by any bodies whether in orbital or translative motion. We will now consider the principle of the Voltaic cell.

P. 48. The action of the simple cell is based on the fact that different molecular systems have different capacities for free gyrons.

If a strip of commercial zinc is dipped into dilute acid, such as for instance, H_2SO_4 , a chemical action at once begins which may be expressed by the equation—



Now the molecule H_2SO_4 has a greater capacity for free gyrons than the $ZnSO_4$ molecule, so that in the formation of the latter from the former a certain number are set free. These first pass into the zinc until it is filled up to its utmost capacity, and then they attach themselves to the hydrogen molecules as they escape, and they are thus carried off into the air, and thus to surrounding objects. If now a copper plate is also immersed in the acid and connected by

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a wire to the zinc, the action is at once changed. The combined action of the zinc and the copper systems causes the molecules of the liquid, between the surfaces of the metals, to arrange themselves in parallel cylinders which forcibly retain the hydrogen atoms within the liquid and allow their motion in but one direction, from the zinc and towards the copper. The function of the copper is thus to exercise a pull on the hydrogen atoms that the zinc does not require, so that what amounts to a rapid process of atomic substitution goes on amongst the molecular systems, in the liquid that lies between the plates. There is thus eventually an excess of hydrogen towards the copper which results in the liberation of this element from the surface of the copper. Whilst this operation is going on within the liquid, the gyrons set free at the surface of the zinc first saturate the zinc, then the copper wire, and finally the copper plate, and if no means is then provided for their dispersion the whole action ceases. Unless polarisation takes place they find the required dispersive agent in the hydrogen atoms, and thus whilst these continue to be liberated the whole operation may be continuous. If the hydrogen atoms do not escape freely, the gyrons are not carried off and the action ceases. If an oxidising agent is used, the free gyrons may then pass into the new molecules thus formed.

The whole action then consists in the breaking down of one molecule and the formation of another, and if the molecules are of the right form free gyrons will be liberated, and the number thus liberated will

be determined by the number of molecules that are broken up. To reverse the process, the gyrons which have been liberated must be reinstated.

P. 49. If we now cause the wire which constitutes the path of the gyrons, which have been set free by the operation described in the last paragraph, to pass close to any molecular system containing a large number of free gyrons, we may produce another most important effect.

No matter at what angle the plane of the contiguous system originally cut the path, the action of Principle II. will very soon arrange matters so that the path of the moving gyrons lies on the plane of the system, and also that the motion of all the bodies in the system, at the nearest point of the orbit to the path, will be increased and in an opposite direction to those moving along the path.

If now instead of one system we take a mass of matter containing many millions of these systems and coil the wire helicoidally, without contact, round the mass, which we may suppose to be a bar of iron, then the various systems within the mass will arrange themselves so that any point on the wire will lie on the plane of the system nearest to it. If we use isolated wire, then the closer the coils of the helix approach one another the more nearly will the planes of the systems approach to parallelism. We will then have a great number of roughly synchronised systems forming what we might call cylinders, the axis of each being parallel to the axis of the bar. Each unit system in these cylinders will generate R and L

helicoidal motions and the resultant of all the similar motions will be in evidence at the ends of the bar. The ends of the bar if bent round will then attract one another.

Futhermore, if the end of a similar bar is brought close to either end of the first, the systems will arrange themselves so that similar cylinders are formed, and since the induced motion will be in the same direction as the compelling motion, the two bars will be attracted towards one another.

If the adjustment of the systems in the second bar is by any means rendered permanent, whether attraction or repulsion takes place between the bars will then depend on the end which is presented.

P. 50. The application of this general effect is so important in practical electrical science that we may follow it up a little further. In this, as in all other cases, it becomes simply a question of finding out what one gyron will do when subjected to any particular set of forces. If we can find this out, we will usually then have a key to the possibilities attached to a large number.

A free gyron included within a system, in any mass of matter must be influenced, like any elemental mass, by the forces which act upon it. If there is but one force, its motion will be in the direction of that force, if a number of forces, it will follow the direction of the resultant of all the forces.

If by any means it is caused to move a certain distance in a certain time, under the same conditions, it will require an exactly equal force to act upon it

for the same time, but in an exactly opposite direction, to bring it back to its original position.

These seem to be very elementary considerations, but nevertheless they represent all that are required to cause the very greatest dynamic electrical effects that we know of.

Let us consider an application—

Let A C (Fig. 3) be a dissipator, say a copper wire, which is in motion in the direction indicated by the vertical arrow. It will thus pass through the consecutive positions A' C' and A'' C''. Let B represent a free gyron within the copper wire.

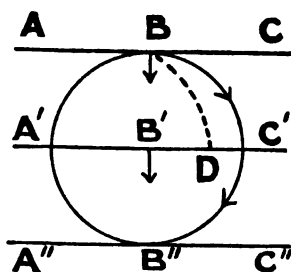


Fig 3.

Now if we suppose the end of an energised bar to be brought close to A C at the beginning of its motion, so that the bar is at right angles to the plane of the paper; then the circle B C' B'' A' will represent a section of the generalised equi-potential sphere through which A C will pass in its vertical motion.* Let the motion in this generalised circle be as indicated for this particular case; the actual motion will depend on which end of the bar is presented.

*If any number of lines similar to PP'', Fig. 4, page 160, are drawn through the neutral point P', and circles are described as in that figure, we get a good idea of the generalised circular motion shown in Fig. 3.

Now if B is free to move along A C in either direction it will certainly be influenced as to direction by that of the ether motion represented by B C', so that whilst A C is moving to the position A' C' the motion of B might be represented approximately by the curve B C' in the case of a perfect dissipator; but will in the case of the supposed copper wire be perhaps more correctly shown by the dotted curve B D. Now if we continue the motion of A C to the position A'' C'' we see that an exactly opposite force will be acting upon B, so that if the motion of A C is uniform, B will return to its original position at B''. We thus see that by this simple method we can cause an alternating motion in the free gyrons contained within a copper wire; and by a simple arrangement it is obvious that we can make a trap so that at the position C' or D the gyron is arrested and not allowed to return to its original position. If now we have a large number of copper wires passing along the same course as A C has followed, and arrange our trap (commutator) to act for each one, we at once have a means of developing a direct stream of free gyrons. Since the velocity of the stream will be dependent on the speed with which the copper wires follow one another, and also on the energy of the motion B C' B'' A', it follows that our stream may reach a very high degree of energy.

We may notice in passing that if the motion of A C had been from the position A'' C'' to A C, the direction of the alternations would have been exactly reversed, but otherwise would have been

identical. Furthermore, we can find by trial that this reasoning is applicable to any combination of direction in the dissipator with whichever end of the energised bar we may elect to consider.

We may demonstrate the converse of this operation in the following way—

If A C comes to rest at any position between A C and A'' C'', say A' C' with B at C', then the only force that is for the moment acting upon B, which is capable of producing translative motion, is in the direction C' B'' and will thus lead to a purely transverse motion across the dissipator but not along it. Motion of the dissipator is thus necessary to cause a longitudinal continuous stream.

Now let us give motion to B by utilising outside sources of energy and direct this motion towards B' along the dissipator, and let the same force as before tend to move it in the circular direction, then B will be forced in the direction of the resultant of these two forces, and if A C is free to move towards A'' C'' it will do so at once. We thus find that we may generate motion in the free gyrons at one point by the application of mechanical energy, and may get a great portion of that energy back at a distant point by employing a theoretically similar machine. The only requisites being that we shall have between the two machines two dissipators, one for the gyrons to travel along in going from the first machine and the other for them to travel back upon. The latter is just as important as the former, for to keep on sending out gyrons our machine must receive them from somewhere.

This represents a simple statement of the principle of the dynamo.

P. 51. We have now outlined the result which may be derived from two simple phases of the possible motion of the free gyrons.

- (1) When in temporary orbital motion.
- (2) When in temporary translative motion.

These represent all the possible distinctive motions of which it is capable, but now we have to examine the possibilities of the intermediate stages when it is just passing from (1) into (2) or from (2) into (1). In other words, when we are either starting or stopping direct translative motion. Here again it becomes a question of considering the principal forces to which any single gyron is subjected.

To refresh our memories we may repeat Principle II

Principle II. An extraneous point, contiguous to the path of a rapidly moving gyron, is repelled from that body if in front of the critical plane, attracted if behind and impelled in a parallel but opposite direction if on that plane.

Now if a number of gyrons are following right after one another along the same path, a contiguous point finds itself at once on a certain curved line of force emanating from the first, and if the velocity of the gyrons is continuously increasing, each one severally produces an effect as if it, like the first, was just starting. Each one on its own account generates a vortexial tube of ether motion about its path, and this vortex is connected with the gyron

that causes it only at the first instant of its generation. Thereafter, it works out along the critical plane at that instant with an ever increasing radius of propagation like any ordinary wave. An external point, meeting one of these vortices, will then first receive an impulse in an opposite direction to the motion of the body that had caused it, and immediately thereafter an impulse in a similar direction to that motion. In stopping or starting the stream along the path, these two impulses will always be transmitted to the extraneous point. If, on the other hand, the stream is constant and regular, the vortices will follow one another so rapidly that interference will result, and the point will receive no impulse; or perhaps rather will receive so many adverse impulses that it will have no resultant motion. If the stream is constant, and the point is approaching or receding, its resultant motion will be the same as in the cases of stopping and starting, and obviously the more rapid the approach or the recession, the greater will be the effect produced. Fig. 4 will make the process clear.

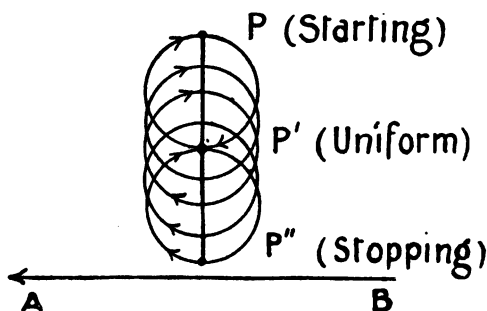


Fig 4.

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P P' P'' is the external point, and A B the path of the stream of gyrons.

Fig. 4 represents a section of the vortices on one side of the path A B, in any plane. The motion in each is as shown.

If instead of a single point or gyron, we have millions, contained within the systems of say a copper wire, which is running in the same direction as another wire carrying a continuous or alternating stream, we can thus see that in the first wire we should be able to produce an alternating stream, specific as to direction, which would be known in electrical science as an "Induced current."

P. 52. We might multiply examples in illustration of the doctrine of motion which is here advocated, but they would convey no new ideas. It is an easy matter to invent explanations of discrete facts if we have a sound underlying principle to guide us. The elaboration of the principle has been the aim of this work, and in working out such a principle it is not purely a question of how well or how badly we can explain any one fact by its aid, but will that principle, if exhaustively elaborated and intelligently applied, find a place for that fact in the branch of science to which it belongs, and at the same time a place for the branch in the general cosmology, and this, it is claimed, the positive and negative electrical conception can never do.

The explanations offered of some of the principal electrical effects is admittedly crude, but the crudity is intentional. Detail in a case of this

kind is laborious and adds not a particle to the value of the conception as a whole. If the main intention is wrong, then the details, no matter how elaborate, will also be wrong. Enough has been written to indicate the real intention, and that is all that is necessary.

The doctrine of motion as here applied to electrical science is in no ways different in its fundamental requirements, when applied to that science than when applied to any other. It is simply extended and that in a perfectly natural or at least logical manner, and in that respect it may fairly be claimed that it differs from some doctrines that have been advanced.

In its development we have found it necessary to cast aside the old and useful servants of former days and to substitute in their place, younger, more virile, and more generally capable servitors. That is all.

Electricity represents after all but a very small part of the problem of the universe. There are other and larger fields, even yet to be traversed, wherein to be consistent we must seek for an electrical explanation, since that is the trend of modern thought; but we may anticipate the exploration of these fields to the extent of saying here that in them electricity has no place.

All the facts that, from a utilitarian point of view may reasonably be classed as electrical, fall naturally into the place assigned to them here; and it will require very comprehensive arguments, and many

new and at present unsuspected facts, to prove that they can ever be assigned to any higher place in the general scheme of the universe.

We have still before us the question—

Q. What is electricity ?

In the light of what has gone before, this question, unqualified, now presents no difficult to us. The answer is simplicity itself, it is :—

A. There is no such distinct entity.

If the question is qualified a little, and put in a slightly different form, it is possible to answer it more explicitly.

Q. What is the cause of the effects that are known as electrical ?

We may answer—

A. All the effects which are known as electrical, are directly caused by explicit motion of the smallest single bodies of which we have any direct or inferential knowledge.

In further elaboration of this answer we may define the “Explicit Motion.”

Static effects are due to motion, temporarily restricted by or within any molecular or atomic system.

Dynamic effects are due to purely translative motion between any two points.

Also, “Single bodies” may be enlarged upon.

“Single bodies” refers to single gyrons, as distinct from the primitive groups of gyrons which go to make up atomic systems, and also specifically refers to gyrons, as distinct from corpuscles or

electrons, which have no place in the gyron theory.

P. 53. Even if this view of electricity is accepted, the problem of the universe is still almost as far from solution as before. Of Absolute Energy, the cause of the gyron, we know nothing. The very acceptance of any such view as is here advanced may in years to come be adduced as evidence of the present incompleteness of our knowledge, for it must certainly be still a long way from the great reality. But if in its elaboration we are able to eliminate one of the greatest uncertainties, if in fact we are able to do away with the whole modern conception of electricity and its attendant mysteries, will it not be a simplification, and therefore an advance?

We can reduce all the effects which are attributable to electricity, to simple attractions and repulsions, and if these can be explained as mechanical effects produced by causes which we need in a feasible explanation of other physical facts, then why should it be necessary to maintain that there is any such distinct entity as electricity at all?

But, it may be argued, we postulate a phenomenon, a something which cannot be explained, as the basis of the argument contained in these pages, Absolute Energy, which gives a start to all the motion which is here dealt with, may be electricity, which would then assume an even more important place in the universe, than heretofore. This contention however presents difficulties which have already been dealt with. Electrical effects can be explained as due to the translative

motion of the particle, and it is difficult to conceive how electricity can be the cause of the existence of the particle and hence of itself. Electricity becomes then at once a secondary force. It cannot be the primitive form of energy to which all other forms are referable.

Many great conceptions have had their day and been forgotten. Phlogiston, for instance, was a conception that in the then state of knowledge, one hundred and seventy years ago, satisfied many great minds. Further facts and discoveries worked its downfall, and it was consigned, not unhonoured or unsung, to historical oblivion. Even in our own time, has not the once impregnable theory of atomic indivisibility met with a similar fate, and from similar causes ; and shall we then be accused of ill-using our precedents if we surmise that a similar fate may await the scientific, apart from the utilitarian, conception of the distinct electrical entity. If this should be its fate it will not have been treated more unkindly than other great ideas, for further facts and discoveries will have also wrought its downfall. The discovery of the corpuscle or the gyron, and the tremendous possibilities attachable to the almost inconceivable energy, which it is capable of developing by reason of the velocity to which it may attain ; gives us the first glimmering of a reality, wherein the hazy uncertainty of the whole electrical conception is supplanted by a mechanical certainty of transcendent possibilities.

CHAPTER VII.

DISSOCIATION AND DEVOLUTION.

A definite impulse is necessary to sustain the motion of the pendulum and the same is true of the internal motion of the atom. If the required impulse is not received, its tendency must be towards devolution, which is then a natural process—the result of too little energy—whilst dissociation may be caused by natural or unnatural processes, as the result of too much energy.

CHAPTER VII.

DISSOCIATION AND DEVOLUTION.

P. 34. It seems to be hardly necessary to go into the question of electricity in connection with dissociation. The latter may be indirectly the cause of the former, in that the free gyrons which are necessary for the production of electricity, may be the products of the dissociation of some bygone atomic system, but this is all the possible connection that can ever exist between them. If one or two free gyrons leave every atom in an elemental mass, it can hardly be claimed that, on this account, dissociation has taken place. The restricted bodies which form the atom, and which give to it its characteristics, and which *are* the atom, still remained unimpaired. But though it seems to be impossible to find any direct connections between electricity and dissociation, there are a few general considerations that may be treated under this heading, which have a more or less direct bearing on the constructive detail of the atomic system. In view of the close connection between these details and the electrical qualities of an atom, a general discussion of a few of the effects which have elsewhere been ex-

plained as due to dissociation, may afford us some useful ideas.

As against the theory of atomic evolution advanced in former pages we might suppose that the process has been entirely downwards and not upwards. We might suppose that the primitive nebula of spiral form, from which it is conceivable that our planetary system has been evolved, was itself an agglomeration of atoms of huge dimensions as compared with those in existence to-day. We might further suppose that these large atoms, as their constituent gyrons lost more and more energy, were themselves gradually broken up, and that the ruins are the existing smaller atoms, which in their mass and general qualities represent graduated co-types of the larger. To carry out this idea we should have to further suppose that the larger types were composed of gyrons, assembled together under some, as yet, undiscovered law; which fixed the size of the group, but allowed absolute freedom to the individual constituent gyrons which were still possessed of too much kinetic energy to be able to associate in primitive groups. As the energy decreased still further, each large atomic spiral was itself divided into smaller spirals, and at length an atomic system was evolved whose unit or hydrogen atom was 256 times the size of the Hydrogen atom that we know. Our atomic system would thus represent the complementary fragments of this by-gone atomic series, and the last to disappear would be the 256 or (16×16) group; whose dissociation products would represent the most frequently

recurring group in our system, just as the larger atoms, like uranium, would represent the largest groups of the former series. But this process must still go on, and we thus see the larger groups of even our own system being dissociated to form a still smaller and less energetic series of elements.

But the whole superstructure that we might build on such an assumption would seem to become unstable when we consider the evidence of a most important witness, namely the spectroscope. The work of Lockyer and other physicists with this instrument seems to prove, that just as soon as association of any kind is made possible by decrease of energy in a star, the most primitive types of our terrestrial atomic series at once appear. Even the building up process from primitive atoms, similar as to type of motion but dissimilar as to mass, may be traced in the appearance of the proto-elements. A full consideration of celestial chemistry seems to establish the fact that the evolution was upwards and not downwards. Even if we allow that the large atomic system generates a co-type of light and heat, which is entirely unrecognisable as such by means of the spectroscope, and therefore cannot be analysed by that means; it still seems impossible that the disintegration products of the largest of these atoms should be anything but the largest atoms in our own series, and these would in consequence be the first to appear. In this case also the relation shown in Tables IV. and V. would be very hard to explain.

In the present state of our knowledge it therefore

appears necessary to believe that our atoms were built up from the smallest possible groups; and that as energy became further dissipated, larger groups became possible, many of them perhaps much larger than the uranium atom. Whatever such large groups may have been formed, the action was spontaneous. That is to say, their subsidiary groups had just enough energy to render the system, as a whole, stable under the conditions which existed at the time of its formation; and since the conditions are ever changing, a time would arrive, sooner or later, when their stability was interfered with and they would suffer devolution. It might be argued that as the smaller groups were formed under even earlier conditions, that they would be the first to suffer. But when we consider that the preponderating influences that are operative on any group, are derived from similar groups in a very nearly identical state of motion, then as the conditions changed, so would the influences to which any group would be subjected. Usually, the most common influences which are received from outside sources, are of the nature of heat and light, and these are capable of supplying energy to all the smaller systems but not necessarily to the larger, if, as we must believe, the energy of the universe is decreasing. It thus seems probable that the causes of devolution lie within the atom and not without it.

The evidence then seems to be all in favour of the theory of evolution which is advanced in former pages; that is to say, that our whole atomic series

has been built up from small or primitive atoms, and does not represent the devolution products of a still larger series. In either case, devolution is a natural result of the loss of energy, and it is a perfectly reasonable conception that this process has already destroyed a large number of atomic systems.

P. 55. According to current theories there are many supposed evidences of atomic dissociation, but in hardly any case except that of the largest atoms can the evidence be considered as final. The ejection of the occluded gyrons from any atomic system can not be considered as dissociation; for although the system, deprived of these bodies will undoubtedly try to get them back, and may be considered as lacking something, it is still a perfect system in full possession of its fundamental properties and characteristics, even without them. The element Palladium has perhaps of all others the greatest absorptive capacity for hydrogen, and when saturated to its full capacity presents no difference in appearance. Whether hydrogen is occluded or not, makes no difference to the Palladium molecule. With it, it is a Palladium molecule, and without it, it is the same. It is exactly the same with the free gyron, the absence or the presence of these bodies makes no difference in the actual constitution of the atom. The action of ultra-violet and other grades of light on any element cannot therefore be considered as productive of dissociation.

A black surface, one that absorbs all the light that falls upon it, and is of all others the most disturbed

in an irregular and unsystematic manner, emits a great number of free gyrons.

All grades of ultra-violet light cause the ejection of free gyrons and their efficiency in this respect reaches a maximum at the lowest extremity of the spectrum.

These cases illustrate the two principal methods of ejection. In the first case the various systems are violently disturbed and the occluded gyrons with them. In the second, the bodies are ejected by the direct impact of the smaller and more rapid vibrations. In the X-rays we have a still smaller and more rapid vibration, and it is able to pass between, not only the various systems, but also between the free gyrons, and consequently does not disturb them to an equal extent.

P. 56. The phenomenon known as catalytic action is one of the least explained facts in chemical and physical science, and is also one of the most important.

That a minute portion of an element or catalyte put into an inactive mechanical mixture of different chemicals, should at once cause these to become active and to combine chemically, is a fact of great interest; and the interest is increased when we remember that usually the catalyte has no place in the compound that it helps to form. The action is by mere presence alone. This simple action is not confined to any one isolated case in chemistry, there are many such; and it is not in this science alone that the catalytic action may be used, in conjunction with

the gyron theory, to elucidate many unexplained facts.

In general physics and even in physiology many effects may be easily explained as due to this action which otherwise are entirely inexplicable.

The colloid metals and various compounds such as disastases, toxins, and such like, have many properties in common. In the processes which produce these states of matter there appears to be little evidence that anything material is added to or taken away from the elemental atoms concerned. That there is a difference in their properties as colloids and toxins, when compared with the same elements in ordinary form, is admitted; but that because there is a difference, there must be a material abstraction or dissociation, is an inference that the facts do not seem to sustain. The difference may be entirely due to a different state of motion in the constituents of the atom or the molecule when in these states, and that this view is tenable is proved by the fact, that whatever the effects produced by any of these bodies, they are always due to a catalytic action. They are induced by the mere presence of the bodies which have been named, and the bodies themselves do not usually enter into whatever compound their action may produce.

The influence of minute traces of an element, when introduced into a mass of another element, upon the physical properties of the latter, is another effect that can only be understood by supposing a similar action.

In physiology, the methods of propagation which may be noticed in various plants, wherein the sexual

elements are separated by a distinct tissue, but yet effect one another, is another case which serves to illustrate the importance of the catalytic process.

Everywhere in Nature there are evidences of the action of the catalyte. The influence of the more energetic body upon the less energetic, the interaction of energy and the something that is energised.

In the gyron theory this process is of special importance, for but few chemical changes take place without a slight catalytic effect. Although so important, the process is of the utmost simplicity and its general principle may be stated in a few lines.

If two dissimilar molecular or atomic systems are brought close together, so that their planes are parallel, and their centres as close as possible, the action of Principle II. causes the faster moving satellites to impress their motion on the slower, and conversely, the slower to impress their motion on the faster moving. The general tendency is towards equalisation of the velocity of orbital motion in both systems.

We may thus have a mechanical mixture of two elements in which there is no actual chemical combination, but the introduction of a small quantity of some other element may change the orbital motion of one of the elements in the mixture and thereby fit it to enter into chemical relations with the other.

The same principle underlies the chemical activity which is sometimes noticeable in what is known as the "Nascent state." In this case, the atomic system concerned is simply coming down from an abnormal,

catalytically induced state of motion to that which it has under normal conditions.

Now, it is plain that although the interaction thus stated, is mutual as between the catalyte and the system affected, it will as a general rule be necessary to have the higher velocity in the former. It must be energetically capable of impressing its characteristic motion on the other. We must therefore conclude that any body or system which is capable of producing catalytic chemical or physical action is one whose components are moving at a naturally or induced high velocity.

We thus have a reasonable explanation of the colloid metals and other bodies which are analagous in their effects upon other forms of matter, without admitting dissociation. It is obvious that any such change of velocity in any system which is capable of producing the physical difference that may be observed, must necessarily increase or decrease the molecular absorptive capacity for free gyrons, and must cause in many cases the ejection of these bodies at a very high velocity.

It is also obvious that effects may sometimes be produced by influences whose action might be unsuspected when the final result comes to be considered. The cause of the chemical or physical state may have ceased to exist in the form which was necessary to produce the observed effect.

P. 57. It is now a fact of common knowledge that practically all bodies are radio-active, that is to say, that under special or normal conditions they emit

small particles which are in every way similar to our gyrons. There seems to be, however, no case as yet discovered where this fact alone can be accepted as positive evidence of devolution.

If, however, it can be shown that groups of gyrons instead of single ones are being ejected, then there may be some grounds for supposing that devolution is taking place. We have as yet no evidence of the ejection of such groups, except in the case of the largest atoms. Take the case of radium. The work of many eminent scientists has established the fact that this element is continuously and spontaneously ejecting a vast number of bodies, which have been determined as possessing a mass about twice the size of the hydrogen atom. They are known as the Alpha rays. Now if we look at Table I., we see that it is necessary to suppose that there is an atomic group just twice the size of the hydrogen atom, and whilst this element is entirely unknown it is quite possible to surmise in a general way what its principal characteristics should be. It will probably be even more inert than any member of the helium series. It may be so inert that normally, it is even incapable of forming a cohesive mass without the aid of the atoms of another element. On account of its small mass it may behave in very much the same way as hydrogen, and this small mass, in conjunction with its constitutional inertness, may cause it to be occluded within the vast intra-atomic spaces, that must necessarily exist within the largest of the atoms. In this respect it might be supposed to act

towards radium as hydrogen does to palladium. That some of the radium atoms are in a very unsettled condition, that their components have been caused to leave or have not yet arrived at the principal plane in each system, and are now following planes which are indicative of superfluous energy, is shown by the continual emission of heat. But there is a necessary corollary of this supposition and that is, that under the circumstances, all occluded free gyrons and small systems will be ejected from each system that is subjected to these conditions. The process would be exactly analogous to the emission of free gyrons by heated metals, or the emission of occluded hydrogen atoms under the same conditions, the only difference being in the case of the larger atomic system that it is emitting larger bodies. We see then that the mere emission of alpha particles, without attaching other conditions, need not be accepted even in this case as complete evidence of devolution.

Let us, however, look at the facts a little closer—

- (1) Radium emits alpha rays, which are particles about twice the size of the hydrogen atom.
- (2) At the same time it emits beta rays, which are equivalent to free gyrons.
- (3) It also develops X-rays.
- (4) It emits an emanation, which appears to be of the nature of a gas but induces or indirectly causes radio-activity in practically every body that comes near it.

- (5) By heating the radium the quantity of emanation given off is greatly increased, but after a while almost entirely ceases.
- (6) The power of emitting the emanation is regained after a time.

Under normal conditions (1), (2), and (3) do not form conclusive evidence of devolution. The X-rays especially are ether waves that may be emitted on the bombardment of almost any element by free gyrons, not by actual impact of the latter but by their motion when influenced by other systems.

In (4), (5), and (6), however, we seem to have evidence of devolution. By heating the radium all occluded particles are driven off, so that when after a lapse of time, it is found that the power to emit further large quantities of the emanation has returned ; we must conclude that the supply has been derived from internal sources, and must therefore be caused by disintegration.

The cause of the disintegration that thus appears to be taking place in the radium atom, is in the first place, probably, the loss of energy by its moving components. The formula of the radium atom is $[160+8(8)]$. The magnitude of the central body, in conjunction with the decreased motion, probably causes such excessive tidal deformation of some of the 8 groups that disruption takes place. If our own satellite, the moon, was to have its orbital motion considerably decreased both as to radius and velocity, we should realize an increased tidal effect on this

planet, and the same forces would be at work in the moon itself.

This action would be quite sufficient to account for deformation and subsequent disintegration of some of the 8 groups, and the ejection at high velocity of the fragments.

In the ejected material or emanation we have a substance that is of great interest.

Experiment has shown that the emanation consists principally of alpha rays or particles, that are about twice the size of the hydrogen atom. In former pages we have endeavoured to show that the existence of an element having atoms of just this size is a reasonable conception, and it is in fact a necessity in the evolutionary scheme which we have advanced. But the qualities of this element must almost certainly make its existence in appreciable masses an impossibility, under present natural conditions. Now if we admit all this we have at once a solution of the mystery of the emanation.

The emanation upon leaving the atomic system consists of a vast number of these binary primitive atoms, which are nearly identical as far as their mass and general construction is concerned, with a molecule consisting of two hydrogen atoms. They are, however, entirely differentiated from the latter by reason of the intense activity of their internal motion. In addition to their internal motion, they have also various degrees of translative motion, and those particles whose kinetic energy is the greatest, are shot off at a high velocity and produce radio-

activity, directly or indirectly, in proximate matter. The binary groups which are not thus ejected have still a very high velocity, and if left to themselves gradually lose a portion of this energy, and eventually come down to a point where, subject to the action of Principle II., they enter into binary molecular relations with one another. They, in fact, then form another binary group which is related to the atom of hydrogen as 4 : 1. But they have still a very high degree of energy, and on this account they are still unknown to us. Give them time, however, and they eventually betray themselves. Their spectrum sooner or later identifies them as the element, which of all others our theory would lead us to expect, namely—helium. They have lost their surplus energy and have assumed a condition of stability as a primitive atomic system.

In this process we have an exact representation of what occurred, a few million years ago, about the great centre which now is our planet; the only difference being that the changes that now take place in a few minutes or hours, then took millions of years to accomplish. The process of forming the helium atom from the emanation, would still take millions of years if sufficient energy was in evidence, in the form of ether vibrations, that would synchronise with the motion of the binary group which consists of two alpha particles.

This evolutionary stage is well illustrated in some of the existing stars, whose spectrum discloses the existence of a preponderance of helium over all other

elements. These stars have simply reached epoch 4 in their evolutionary process, and in a few million years will pass on to epochs 8 and 16.

The real result that has been achieved in the laboratory in the synthesis of the helium atom, is the production of the conditions that at present exist in these stars, and that once existed about the centre of the material of which this planet is built up. In each case the helium atom has been the product of the dissipation of energy. The process has been more rapid on the earth, because the difference of potential at different points has been greater.

P. 58. A further consideration of this hypothetical element whose atomic ratio is represented by the Figure 2, may lead to some interesting ideas.

To facilitate reference we may call this element "Anonium" or Nameless. Symbol An.

It is well-known that many elements when in the so-called "Nacent State" exercise a very much stronger chemical action than at any other time. Take the case of hydrogen for instance. Under ordinary circumstances this element will not combine readily with other elements, except under special conditions as to heat and pressure. If however we use the hydrogen liberated by the interaction of zinc and hydrochloric acid, combinations may be formed which are impossible if pure hydrogen alone is used. Now, what is the reason of this increased activity? The hydrogen atom itself cannot be considered as having lost or gained anything material, and we must therefore conclude that it is something immaterial.

Under our theory this can only mean internal change in the motion of the atomic or molecular systems concerned. It is in fact a catalytic effect produced by the zinc atom. Whilst in this transient and abnormal state of motion, and only whilst that state of motion lasts, the hydrogen atom is capable of producing effects which under ordinary conditions it is quite incapable of. The effects take the shape of being able to replace other elements in compounds which usually are quite able to resist the attacks of the ordinary hydrogen atom. In other words, the hydrogen atom itself becomes a catalyte, whilst in this state, and influences the motion of other systems to its own advantage.

Now under our theory the elemental atoms are made up of primitive atoms, and the laws which govern the assemblage of the primitive atoms into atomic systems are, in many respects, similar to those which govern the formation of atomic molecules. It would thus seem to be a reasonable contention that somewhere in Nature we should be able to find one or many substances capable of exercising a catalytic action in respect to these primitive atoms, and so to cause interchange or substitution to take place within contiguous but dissimilar atomic systems.

The difficulties in the way of finding such a substance are necessarily great, for its velocity of internal motion must be very great, to disturb the stability of primitive atomic molecules. It must be a very small body moving orbitally at an enormous velocity, a velocity so great that we can hardly expect to find

anywhere in Nature a stable system that will satisfy the requirement.

In the hypothetical element anonium we have, however, just the body we require if we consider its small mass and consequent adaptibility to the development of high velocity. We must, however, remember that if its internal construction and mass relations fit it for the attainment of immense energy, they also insure that under the conditions existing at present on this earth rapid dissipation of that energy will be just as easy. If by any means we can put this element into the nascent state, it will, for a short time, be probably one of the most powerful catalytes in Nature, and whilst in that state of energetic motion, it should be capable of causing disruption of some of the smaller and perhaps even the larger elemental atoms.

Furthermore, we might expect that it will, like hydrogen, be able to exercise this power to its own advantage, or in other words, it will be able to displace a y group and itself occupy the vacated place in relation to the free x group.

Now we have already supposed the anonium atoms to have formed themselves into transitional binary primitive molecules having great energy; upon losing a portion of which, they become evident to our senses as the elemental atom—helium. But before they reach this state, whilst they are in the nascent state, when in fact, they come fresh from the radium emanation; might it not be possible to conceive that they have sufficient energy to enable

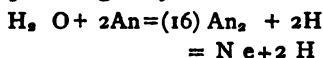
them to exercise a catalytic power on some other primitive atom or molecule and to do it to their own advantage, and thus to build up the next or any subsequent atom in the helium group. If such an operation should ever be performed, the product would represent a molecule of the form—

$$[m(16) + (m \pm n) An_2]$$

—representing Ne or Ar, etc.

Let us for the moment accept this proposition and also the relation which is shown in tables IV. and V., and we have at once a basis on which to start a new science, or rather we should say, a new branch of science, which might be styled simply, Intra-atomic Chemistry.

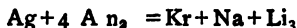
Let us suppose that group 16 is a base or primitive molecule which is itself capable of acting as an element, but which has very different valencies according to the state it is in. Then we might express a simple imaginary substitution thus—



and remembering that 16 has very different valencies, we might have a purely primitive reaction thus—

$$[5(16) + 4(7)] + 4 An_2 = [4(16) + 4 An_2] + [(16) + (7)] + 7_2$$

Which being translated into terms of elemental transmutation would mean—



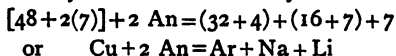
or silver + nascent anonium = krypton, sodium and lithium.*

* These pages were ready for the printer on August the 27th, 1907. Sir William Ramsay's discoveries as to the effects

As to what laws would govern the actual reaction at present we can only guess, but whatever they may be, the general holding power or valency of any 16 must be influenced by the relations which have been shown to exist in Tables III., IV. and V. A consideration of these tables will show us at once that whilst the holding power fluctuates for any table VIII. group, as we read down; it evidently increases steadily for any series as we read from left to right. These relations should nearly enable us to foretell with certainty what reaction or what substitution any particular operation should be able to produce.

It might now be argued that if this primitive molecule may be considered as capable of producing such big results, the actual building up of the atoms must

of the emanation in producing transmutation were published at the beginning of August for the first time. It is clearly impossible that this whole theory could have been elaborated in the intervening time. It has taken very much longer than that, and it has not even been deemed advisable to alter a single word of the original completed manuscript in consequence of the published details. It has been deemed possible that a consideration of the departure of the observed facts from the crude theory may lead to valuable deductions. On looking up the notes which were worked out in December, 1906, relating to this paragraph, the transmutation or perhaps more correctly the dissociation of copper as well as of silver was worked out, but was omitted as only one example was required. It may be given here as it is one of the experiments which have been made by Sir William Ramsay.



have been a most complicated process. In reality, however, whilst the total amount of this element anonium, that exists upon the earth at present, may be fairly large, the portion that is sufficiently active to produce catalytic results is very small; and that portion, which even if sufficiently active is so situated that it can be effective, must be still smaller. In the beginning of things, for a time there was hardly any other element, and during that period it was only possible for one anonium atom to act upon another similar atom, and therefore there was no possibility of producing any such results as are here suggested.

P. 59. Now as to the relative position which dissociation occupies in the economy of the universe, we have seen that it cannot be considered as absolutely demonstrated, that anything but an

From what has been published concerning the experiments, it would seem that this last reaction is not entirely correct, but the discrepancy may lead to valuable information when both the theory and the experimental results are considered together.

Sir William Ramsay, in a paper on the variability in the products resulting from changes in radium emanation, described a series of experiments suggested by the behaviour of radium in decomposing water. A small excess of hydrogen was produced in this case whose presence it was difficult to explain. To pursue the inquiry copper compounds were substituted for water. In operating on copper sulphate the residue was found to give a spectrum of sodium, which was not surprising, but lithium was detected, the presence of which could not be explained. Further experiment was made using pure electrolytic copper, and every care was taken to test for

infinitesimally small proportion of our earth is at present under-going devolution. In the case of other worlds that are on the down grade the same as ours, dissociation can occupy a but little more important place. In times gone by it was probably much more rapid as regards some few elements, but these could still have formed but a very small proportion of our planet.

As regards outside bodies such as the sun, all the evidence we have seems to strengthen the contention that they are still in the atomic building stage, and have not yet got any atoms that are large enough to be considered as subject to the same dissociation laws that govern the disintegration of radium. It has been claimed that the heat of the sun may be explained as due to the presence of radium or to a general process of atomic dissociation. This is almost equivalent to saying that if you do work on

lithium, but after the experiment lithium was still found. Nitrate of copper was employed with all care, to avoid impurities, and after exposure to the emanation lithium was again detected. In another experiment the emanation was left out and no lithium was detected. Again, when the emanation was dissolved in water and no copper salt used, the result was to give, not helium, but neon, in considerable quantities. The spectrum showed some lines in the green which might indicate new elements. The real difficulty was to explain why water gave neon and not helium. It might be suggested, as a working hypothesis, that the emanation was possessed of enormous energy, and according to the amount of energy used different products might be produced. From *The Times*, Aug. 5, 1907.

the fly wheel of a steam engine you can produce steam in the cylinder. Helium may be formed in one portion of the sun and dissociated in another, but assuredly it requires an intense application of energy to bring about this result. It uses up energy instead of producing it. In other words, a great number of particles must have changed some of their energy of position, at a distance from the centre of the sun, into intensely rapid vibrational or orbital motion, subject to Principle II., in a position nearer that centre, to produce the energy that is necessary to dissociate a helium atom by sheer force. It is easy to realise that in the sun the stage has not yet been reached where a large atom can be dissociated owing to its lack of energy. The potential energy that has been thus lost by any such particles can never be regained by them, for it is at once dissipated to the uttermost parts of the universe, by means of the Beta-waves created by their orbital motion. In devolution, as we know it on earth, certain small bodies are dissipating energy which they have received, not created, and they are only noticeable by reason of the violence of this dissipation.

Whence then comes the energy of the sun if dissociation or radium cannot be supposed to account for it? An ether motion, such as heat for instance, can only be created by a body that is in a particular state of motion. Get away from the point as we may, we must return to this proposition, and its solution is the same in the sun as in the smallest primitive atom existing on earth. Its motion must cease in a

certain definite time, like a pendulum, unless it receives a slight access of energy from outside sources, during every cycle of its movements. Where then is the main spring that gives up its energy to keep up the motion in each little system in the sun? We can only conclude that it is the universe itself. It cannot be radium, or dissociation, or emanations, or any of these transitory interactions of matter and energy. These phases may for an instant imitate the sun, because for a while they return to the primitive conditions that obtained at the time of their synthesis; at that time the condition of our planet was somewhat similar to that of the sun at the present time.

If the earth was suddenly given the same amount of internal energy that it had in those times, then the energy of the synthetic, which are now the disintegrative, elements of radium, would not be as transitory as it is to-day. Whatever state of motion they were put into they would maintain that state for a lengthy period; because, when in that state, they would be supplied with energy in the proper form to enable them to maintain it.

The fact that the radium products soon lose their energy, is a proof of the general contention; for the type of ether motion or energy which is necessary to sustain them cannot now get to the earth in sufficient quantities from external sources. The energy required would be in the form of waves, that would be away down in the ultra-violet; and whilst these are coming continually from the sun and other bodies

towards the earth few of them ever reach it. They are received and again dissipated by the outside layer of our atmospheric envelope.

Untold millions of ether vibrations leave the sun every second, but also are received by it ; so that the total energy due to the original potential energy of its compotent gyrons in the beginning, is spun out to defeat almost time itself. Its present temperature represents the total on various accounts, such as shrinkage, meteorities, refund on dissociation, etc., but raise the number of different accounts as we may, in striking the final balance, the refund of old and access of new energy from the whole universe, must have a most important place. If as we must suppose this main spring is running down, then must the total energy of the sun be failing ; but the time must be still long distant when it will have failed completely.

It is obvious that all the waves falling on the sun are not visible. As a matter of fact the invisible rays must greatly transcend the others in number. It has been estimated that the total number of stars made visible by a powerful telescope exceeds 100,000,000. Celestial photography brings this number up to say 120,000,000. Supposing that we accept the theory of limitation and this number as a maximum possibility for the visible light emitting stars of our universe, we must still admit it as a possibility that there are quite this number of stars which have not yet reached the stage at which they are capable of the mechanical emission of visible light, and that there is a further

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number, possibly quite as large or larger, which has passed this stage. Although these stars are not visible, they are still emitting energy in the form of ether waves, and these waves are helping to sustain and level up the energy of the sun and all other energy-emitting bodies in the universe.

CHAPTER VIII.

LIFE.

"With the new knowledge acquired by science, the enlightened mind no longer needs to see the fabrication of protoplasm in order to be convinced of the *absence* of all essential difference and all absolute *discontinuity* between living and not living matter."—"The Nature and Origin of Life." Pp., 250. London, 1907.

—Prof. Felix Le Dantec,

Professor of the Faculty of Sciences at the Sorbonne.

Perhaps the keenest analytical argument to which the subject—life—has ever been subjected has led up to this conclusion. The following chapter will be devoted to showing how the synthetical argument contained in these pages may be extended to meet and agree with the above conclusion.

CHAPTER VIII.

LIFE.

P. 60. In former pages electrical science has been termed "mysterious," but if we can with truth apply this term to that particular branch of knowledge, what shall we say of Life?

We seem to be on the threshold of knowledge with respect to the inner meaning of electricity, but even when we know all that there is to know about it, there appears to be little hope that in the solution of this problem we shall also find a solution of the other. The first may eventually be placed upon the category of the things that we know, whilst even thereafter the other may remain amongst those that are unknown, and even perhaps within the region of the unknowable. Because, however, it is difficult and apparently incomprehensible, is not sufficient reason for us to pause in our efforts to dispel the mystery of life, or to place it upon the category of the things that are known. We may derive courage from the thought that if there is a general scheme to which all the facts of the universe conform, and if a place is eventually found in it for the greatest fact of all—life—this conformity will not detract one iota from the magnifi-

cence of the fact itself; because it ceases to be isolated it will not lose its grandeur, it will simply add grandeur to the scheme as a whole. If to the Originator of the scheme all things were possible, then assuredly this also was possible, and would afford in its conformity greater evidences of power than in its non-conformity.

Life is to us the most interesting fact of all, but it is at the same time the most incomprehensible. Yet in the multifarious effects for which it is responsible, there must surely be some simple one that will help us to co-ordinate the main fact with those others that outline the general scheme of the universe.

In the inorganic world almost every process, every sensation, is reducible to terms that are susceptible of mechanical, and therefore mathematical, treatment. From gravity, the first, to devolution and practical neutrality, the last, stages in the evolution of matter, we can realise a possibility of requiring but two indeterminates which are in their last definition, simply energy and something to expend it upon.

Every discernible effect is thus but a term in one great series which comes from the infinite and returns thereto, and is more or less appreciable to our senses according as it approaches the maximum or minimum effect that is possible.

It would be strange indeed if a system as large as the universe itself was less inexplicable than the smallest living cell of which we have any cognizance. Because it contains the germ of life, is it then to remain unknown?

What is Life?—Is the question which we must put

ourselves in this chapter, and although we may not find it we may rest assured that there is an answer, and one that will not involve a great mental effort to understand. Also we may feel sure that its very simplicity is the principal reason that it still remains indiscernible, for it involves almost a greater mental effort to simplify than to elaborate, and human tendencies are therefore towards the latter.

P. 61. Now in former pages we have made an endeavour to trace the evolution of the universe from a state of dispersion to a state of evolutionary solidarity, of which our own planet is for us the best instance. So far it has been an unbroken progression, and we want now to find out the next term, the next possible interaction of energy and the something that it works upon. We want to find the connecting link between the inorganic world which we have so far studied and the organic world to which we ourselves belong.

There are countless stars in our universe which are in a primitive or gaseous state even in our time, and these are representative of a stage through which not alone our planet but every other celestial body may be deemed at one time or another to have gone. There is not one single body out of the whole vast number which is known to us, that we have the slightest reason to suppose, started into existence at anything approaching the stage in which we find the earth at present.

Even the most elementary form of life could not exist in a gaseous star, and there is therefore no

star known which can be considered as having disseminated the germs of life throughout the universe. If then we would know the reason of life, we may confine our efforts to the consideration of but one possibility, for there seems to be but one, and that is, abiogenesis, or the evolution of living matter from the dead atoms and molecules which we find around us.

Furthermore, there is no evidence that any such process is in progress to-day; in fact it seems to be well ascertained that all existing and extinct types were only arrived at after countless ages of evolutionary development. We may therefore conclude that at one long distant epoch in the world's history the natural conditions were just suitable for the spontaneous transition of a complex chemical compound into a new state, in which it became endowed with the specific quality known as life.

It is not necessary to believe that it is now impossible to reproduce the original circumstances by artificial means. On the contrary, it would seem to be entirely possible that, given a complete knowledge of the truth, such an effect might be realisable.

To find out anything about life we must begin at the beginning. We must go back a great many millions of years to a time long before human existence was possible. We may well believe that the first stage in the evolution of living matter was accomplished at the very earliest time that it became possible. That is to say, as the natural sequence of events made it possible for an aggregate of the ordinary chemical

molecular forms of certain elements to assume the quality which is known as life, it did so. It was probably a natural transition due to the circumstances that existed during some evolutionary epoch, and it is quite possible, that neither before that time, nor since that time have the circumstances been just right for a repetition of the transition.

We find that even the most elementary organisms or organic products are, from a chemical point of view, most complex aggregates of atoms. But whilst the total number of atoms is great, and their constitutional arrangement exceedingly complex, in both the primitive and the more highly organised forms, we find but a few elements represented. Carbon, nitrogen, oxygen, and hydrogen, are the elements which are included in practically all living types; and we therefore see that the first living molecule or aggregate must have been produced after these elements had been evolved, and therefore the date of the genesis of life, must have been well on in the evolutionary process. Also since even the most elementary living molecule, which for shortness we may call a "Biogen," must have been exceedingly complex, and since complexity only became possible after the youthful energy of the components of matter had been worked off to a large extent, life itself can have only become possible at a comparatively recent date. It became possible probably after all the known elements, and even some that are now unknown, had been formed; and after a great number of the

ordinary forms of atomic molecules and compounds, had been either in existence or possible for some time.

We must suppose then that at whatever period this stage was reached, a number of already complex molecules, consisting of carbon, hydrogen, nitrogen, and oxygen, were existing in their ordinary condition, just as they might be to-day; and that gradually or suddenly, some influence acted upon these molecules and caused them to become an aggregate, having a distinct individuality of its own. This individuality then differentiated it from all other similarly proportioned aggregates, which had not been subjected to the influence. In giving this individuality to the aggregate, the influence gave it also certain qualities, which allowed of its being classified as a biogen or living molecule.

Now, in the general scheme which we have so far followed, we have supposed that there is only one way in which an aggregate of bodies can attain a distinctive individuality. Whether this individuality is very stable or merely transitory, some particular state of motion is a necessity to preserve whatever specific characteristics have been obtained. We may say definitely, that under this theory, no distinctive individuality is possible without characteristic motion of some sort. We have followed this idea out from the gyron to the complex molecule, through the following stages—

- (1) The gyron.
- (2) The system of gyrons or primitive atom.

(3) The system of primitive atoms or elemental atom.

(4) The system of elemental atoms or molecule.

We have seen that this series, when subjected to our four simple principles, may be used to explain the main facts in the evolution of inorganic matter ; but beyond this, it does not seem possible to extend its adaptability. But we still have a vast unexplained range of facts, which must be found a place for somehow, and there appears to be only one thing to do and that is to extend the series, and write—

(5) The system of molecules or biogen.

The fifth term in the series then may be considered as a system of simple or complex molecules, and the motion which gives this system its individuality, is a simple extension of the principle which gives the same attribute to the primary terms of the series. The biogen then must owe its individuality to the fact that its component atoms are in an epicyclic state of orbital motion. That is to say, the system as a whole, considered as to its component atoms, is identical to our own planetary system ; if we consider the moon as one or an aggregate of hydrogen atoms, and the earth as an aggregate of carbon atoms, and so on. Now we must see whether this conception will go any way towards fulfilling the requirements, and to find this out it is necessary to make a definite statement of the absolute qualities, which if given to any portion of matter, will make that portion of matter become subject to definition as being alive—as possessing life. To be able to define the most

elementary qualities that must be given to a portion of matter, to change it from being simply an aggregate of elemental molecules possessing no such quality as life, to an aggregate of similar molecules possessing life in its most elementary form, we must seek the assistance of the biologist. We cannot, however, like him, look upon, for instance, the Protozoa, as an elementary form of life; we must look on even this simple development, as a highly organised product of perhaps millions of years of progressive evolutionary processes. But whilst thus seeking to dig beneath his foundations, we may find a definition of life in the qualities or attributes which he certifies as belonging to the smallest particle of living matter that he knows of. We may state the qualities of living matter briefly as follows—

- (1) Its chemical composition is invariably different complex compounds of carbon, nitrogen, oxygen and hydrogen.
- (2) It undergoes constant spontaneous integration and disintegration.
- (3) Its internal changes are strictly cyclical.

These attributes are more or less individually specific, but what we want to arrive at is a generalised definition, and we may therefore summarise the above statement by saying—

That any minute system, of the elements named, is possessed of life, which under proper conditions goes through a cyclical process or metamorphism; in which it obtains individuality at the beginning of the cycle, loses it at the end of the cycle, and during the

term of its existence as an individual, or as a final act of its existence as such, causes another similar system to come into existence, itself possessed of similar attributes.

The cycle thus becomes birth and death and the concomitant act propagation. But as the offspring must be supposed to exist at the beginning of the cycle, in a state of dispersion ; during the cycle its parts must be gradually assembled and annexed to the system, and finally energised, as perhaps the last act of the existence of the system as an individual.

The final expression then for the cycle through which a system must go to be deemed as qualified with life, is birth, growth, propagation and death. This cycle must subsequently be followed by the offspring, which itself assumes the exact individuality of its parent, and during its life it must go through exactly the same cycle.

Now let us suppose that by some means a biogen has been formed, the method or the cause of its birth we need not for the moment discuss. Let us also suppose that this biogen is composed of a number of different molecules, all in a state of orbital motion in one plane, and that this plane is surrounded by an immense number of molecules, similar in construction and composition to those of which the biogen itself is composed.

To conform to specifications as a living portion of matter this biogen must at once enter upon its cycle. It must grow, cast off its offspring, and then die. We must now see whether it is possible to express this

cycle in terms of what we already know, or can explain.

Elementary propagation consists in the act of throwing off the entire products of growth, so that we may at present confine our attention to the possibilities of growth and death. We must then first enquire whether any such processes have been noticed amongst the chemical or physical facts that are known to us, but we must look for the two effects in different directions.

The simple fact of growth is not difficult to explain, for we may say that any atomic system or molecule, which has drawn to itself another similar system, has actually grown, and this method of growth is best illustrated in the process that takes place in the formation of a crystal.

In all crystalline forms, no matter what the system to which they belong, it is a noticeable fact, that whatever the angles between the various sides, if we consider any one side, there is always another side parallel to it. This fact in conjunction with its magnetic properties and the additional fact that a crystal always grows by surface accretion, allows us to form a very distinct idea of the entire process.

Under our theory a molecule can only go on growing or acquiring additional molecules in one direction if by some means the plane of the molecule is held in one position. The simplest way then for causing this restriction is for one molecule to restrict another, the growth for which each would be responsible, would thus take place in opposite directions. Thus any

stable geometrical configuration which we can arrange with six or more systems, wherein each system is held in place by the pull of another at the opposite side of the group, would lead to purely surface accretion or crystalline growth, and would terminate in parallel faces. By varying the form of this nucleus, we vary the form of the resultant crystal, and the nucleated forms which are possible, would vary with the constitution of the molecular systems concerned.

The fact of growth then we see is not hard to explain, it represents nothing more than ordinary aggregation subject to Principle IV. It is the subsequent facts which present the difficulty. The crystal will usually keep on growing as long as it is supplied with the right material, if the conditions are right. It has no tendency to disintegrate itself according to our requirements. The fact of growth in a definite direction is however all that we can ask the crystal to demonstrate for us.

Now as to the other main requirement—the death of matter. The death of a molecular system simply means the termination of its existence as a system, the loss of its individuality, the cessation of the motion which gave it this individuality and the perhaps explosive dispersion of its parts or atoms. In the devolution of the radium atom we have the death of an atomic system, and if we could imagine the radium atom as made up of primitive atoms as large as those groups which form the biogen, we should have in its dissociation an exact analogy to that quality which we require in the latter. Upon dissociation the

radium atom truly loses its individuality, and its parts are dispersed at usually a high velocity. It ceases to retain the qualities which differentiated it from all other atomic systems. It, as a system or individual, has ceased to exist, it has in fact suffered death.

If we could combine these two effects the growth of the crystal and the death of radium, so that one system was capable of the performance of both operations, we should have gained a great step towards the explanation of life.

Now if we suppose that the molecular systems composing our biogen have all been arranged so that their planes lie on one general plane, but that they have no other motion than their own individual molecular orbital motion, and that they are thus held by any means, and are surrounded by numbers of free molecules of similar constitution. Under these conditions they will at once follow the example of the restricted systems in the crystal, they will each attract most strongly the systems that are most like themselves, and each molecule will start to build in both directions normal to the general plane which we have supposed. As long as the first systems are held in their restricted positions they will continue to grow in that direction. Now let us gradually give to the original systems which compose the biogen, rotational motion round the central body or molecule, still in the general plane. We should find that at least some of the growths would follow the motion. We should have at least three biogens instead of one, and each of these would be identical with the first as

to composition, and would also be in a similar state of motion. They would in fact be individually identical to the first.

Now, if instead of being stationary, as we have supposed, the biogen was, upon coming amongst the other molecules, already moving at a high velocity, and consequently possessed of individuality, it would go through just the same process—it would grow. The only difference would be that the selective process would go on at the same time; that the bodies which were being selected were acquiring the necessary velocity to give them finally, as systems, the same orbital motion as the parent system, and consequently the same individuality. The process would be perfectly regular in its operation. First the great central body of the biogen would select its partners. Then one by one the others until the three systems would attain identical composition and velocity, and would thus be similar in every respect. Thus the second operation in the cycle would have been accomplished.

Just about the time that the full motion has been acquired by the two new systems, a change will begin to take place. The component systems of the central biogen begin to feel the effects of the three central bodies, and from their position to feel it more than those of either of the outside systems. As in the radium atom, tidal deformation and subsequent disruption of these systems would eventuate, and would result in a final violent dissipation of the remaining energy, a great part of which would be

absorbed by the new systems, and they would thus have a fair start on their own independent careers. The first biogen has lost its motion and with it its individuality. It is dead. Its offspring go through identically the same cycle, and thereafter the process is continuous.

But before its death the first biogen has not only expended its energy in producing motion in two identical systems, it has also done some work outside the material of which these are composed. If its life had been extended it would have caused more offspring to come into existence. A great amount of selection has already been accomplished, and a great amount of motion has already been given to the materials with which the new biogens find themselves surrounded. They and all future generations start their lives with very different prospects to the parent systems. They find themselves with far less work to do and consequently more available energy to spare. They can thus continuously leave matters even better prepared for their own offspring, until at last a point is reached at which the surplus available energy becomes so excessive, that it is expended in adding on perhaps a new molecular system to the already complex existing type of biogen, and thus the first step in the evolution of higher and more complex organisms is gained.

As this step is been approached we should find that instead of two reproductions, four or even more might be possible; but in any case the central link in the chain would sooner or later cease to exist, and the

two segments or ends would become separate entities, and would find themselves surrounded with the semi-prepared material which was necessary for further progress.

The character of the surroundings of any such single active biogen or chain of biogens (primitive nucleus) would soon become interesting. We should find close to the active bodies the material which they were all endeavouring to acquire most vigorously (primitive cytoplasm) and further from them that which was less energetically attracted, and outside of all the rejects and products of disintegration, (primitive membrane) which were shot off as each death took place. These disintegration products would be in an extremely active state upon emerging; they would readily find partners, and would therefore soon be reconstituted as molecules. The whole active operation would thus result in the liberation of gases and other products, perhaps not originally included in the biogen.

We have now actually traced out the birth, growth, propagation, and death of an individual, and one which is so constituted that its characteristics will be transmitted to other individuals of like nature. Also the process will be not only continuous, but will tend towards the evolution of higher co-types as well as subsidiary and specialised types. We have fulfilled the specifications so far, in that we have now a complex chemical molecular aggregation capable of inducing similar conformation and individuality of motion, in an aggregate of similar molecules. We have followed

it through the required cycle, and in so doing have found that the name "Biogen" is not misapplied.

It now becomes necessary to assign a possible cause for the first biogen. Once we have one, we can see a possibility, but until we can show a reasonable cause of the existence of this pioneer, the subsequent developments are of little importance.

P. 62. In most forms of gamogenesis, it is a noticeable fact that a great difference exists in both the physical states and quantity of the necessary elements. One element seems to be invariably an energiser and the other simply a receptive mass, which contains all the requirements for immediate development. Whilst admixture certainly takes place between the elements in the case of the higher organisms, it is conceivable that the true action is in all cases that which is exemplified in many plants—notably the *Florideæ*, in which some influence is transmitted between the elements, which is the direct cause of subsequent developments. In flowering plants, generally, the contents of the pollen tube do not actually mix with the substance of the embryo cell. Whatever effects are produced in the latter, are due to the mere presence of the former; and evidently the influence is transmitted through a distance that is relatively great, compared with the size of the bodies that cause it. In the human body, and in fact in all the higher organisms, there are many subsidiary organs whose sole function is the secretion of various substance, such as diastases, toxins, etc. These substances are absolutely necessary for the welfare

of the individual, and yet they do not appear to be effective in any other direction than in producing a slight change in some other body which is being used in sustentation or some other physiological process. In producing this change they undergo no physical or quantitative change themselves, and they apparently act by the mere fact of being there—by their presence alone. The principle of action by presence, is evidently one that has a most important place in the general cycle of life, both in its beginning and in its continuation, and as has already been noticed, it has an equally important place in chemical and other science.

If then we find that this process is so important in nature, and is noticeably important in the beginning of even present day life, might it not be possible that the very beginning of all life, the transition process which changed an inanimate aggregate of elemental atoms into a primitive organism, imbued with the quality of life, was also due to this process?

We have seen that if we could once give individuality or specific motion to a group of molecules, so as to constitute them a distinct system or biogen, that thereafter this system might be considered to be possessed of an elementary form of life.

In the evolution of all other compound systems, we have supposed that the potential energy which each possessed was naturally sufficient, or might be made sufficient to cause them to assume orbital relations. In the case of the largest systems, heat has been considered as the energising agent, but in

the case of the biogen this agent is not sufficient. Heat may cause an increased activity within the component molecules, but certainly cannot be considered as having been the agent that produced the orbital motion of the system as a whole. It then becomes necessary to find an agent capable of transmitting this motion, and in view of the principle which we find so largely exemplified in the fundamental processes connected with life, we may figure that agent as being a body capable of acting by presence alone, as being in fact a catalyte, and one that is or has been of more than ordinary energy.

The specifications of this supposititious body are very simple.

- (1) As it is conceivable that abiogenesis once was possible and now is not, this body must have existed many millions of years ago upon this earth, but now does not.
- (2) It must have existed after all known and unknown elements had been evolved, perhaps even after the process of devolution had begun.
- (3) It must have been more energetic than any catalyte that at present exists upon earth.

There is only one possibility that presents itself to us and that is, that this catalyte was of the same type as the An_2 molecule, when on the point of coming down to a state of stability as the helium atom. The only other similar bodies which have ever been in a state that would fulfil the requirements are, the $(4)_2$, $(8)_2$ and $(16)_2$ molecules. Any of these bodies would

probably have had sufficient energy to have caused the necessary motion in our biogen. In the devolutionary process, which we may suppose has already caused the disappearance of many atoms even larger than uranium, we have a possible source of this catalyte. Just as radium is constantly giving off the anonium atom, so might a still larger atom have constantly given off either the (4), (8), or (16) group, and in so doing have been the indirect cause of the motion, which has constituted the biogen as an individual capable of performing the actions of spontaneous accretion, reproduction and disruption, of performing in fact the entire cycle of life—birth, growth, propagation and death. We have then the curious possibility that the cause of life was the devolution of matter; that, in fact, the primary cause of life was—death.

The idea that life is a purely mechanical motion is very old. Thus we find Descartes writing about the year 1636 “. the physical universe, whether living or not living is a mechanism, and that, as such, it is explicable on physical principles.”

In tracing out the very beginning of the highest forms of life, the fertilisation of the ovum of a mamal, Haeckle says:—“The nuclei of both sexual cells, attracted by a certain “affinity,” approach each other and melt into one.” And further on he says:—“That complicated molecular movement of the protoplasm which we call “life” is, naturally, something quite different in this stem-cell from what we find in the two parent-cells, from the coalescence of which it has

issued. The life of the stem-cell or cytula is the product or resultant of the paternal life-movement that is conveyed in the spermatozoon and the maternal life-movement that is contributed by the ovum."

Here we have the idea of some undefined internal motion producing first, a definite mechanical attraction, and secondly, the more complex organisation. The same necessity of internal motion is presented in the very simplest form of living cell. The observed attributes of the cell can only be explained by granting some definite individuality of motion to the molecules that form it. As Huxley says:—"They (the cells) are no more the producers of the vital phenomena than the shells scattered in orderly lines along the sea-beach are the instruments by which the gravitative force of the moon acts upon the ocean."

In the explanation which has been outlined above, we have a mechanical motion which, whilst preserving the individuality of a small portion of matter, allows it to go through a process which may result in constructive metabolism, and therefore in evolutionary complexity, and endows it at the same time with the other physical properties that are required. The explanation as a whole is consistent with the general facts of life, and is certainly consistent with the rest of the evolutionary scheme which is here advanced, and may therefore be considered as a possibility.

If, however, the general possibility of the biogen is admitted, the main point is gained. What catalyte was used, or what atoms or molecules formed the first biogen, it is not necessary for our purpose to discuss.

Whatever the catalyte, the actual mechanical principle involved is simplicity itself, once we have the requisite power and simple molecular arrangement.

By some intense influence a few simple systems or molecules, consisting of the very commonest elements on earth, are forced to assume orbital motion. They in so doing form a complex system having four notable attributes which entitle it to take its place in the universe as the progenitor of all life, both great and small.

It is, however, a long step from this first biogen to the final development, man, and was not achieved in a day.

At a very early stage in the evolution of the biogen progress would commence to follow along two very distinct paths. There would always be a tendency for the biogen to exist in static aggregates, as is the case with any simple molecule, and conditions would determine the physical state of this aggregation. The broad differentiation which would eventually occur would be based on the position which any aggregated biogens assumed with respect to the common supply of semi-prepared material, which obviously might be mainly included within the aggregation or without and surrounding it. In these two different types of aggregation we should have the primary differentiation between the animal and vegetable kingdoms. In general, heat and light would be necessary for progress, but an excess of either might cause disruption. Without abnormal heat, and without the

necessary material for growth, the biogen might retain its individuality for a very lengthy period. Growth and propagation are necessary to make it fulfil its cycle. A biogen might thus remain for thousands of years in existence without undergoing any progressive cycle, but subjected to the right conditions and supplied with the right material, it would at once start on its cycle of evolution and death. This dormant stage is exemplified in all kinds of plant seeds, which retain their qualities indefinitely, but if placed in the earth and supplied with water and heat, at once start the evolutionary cycles which are necessary in the production of a plant. The same process takes place in the case of gamogenetic or any other form of impregnation.

P. 63. In its final definition then, the biogen is a system capable of almost infinite diversifications as to its constituent bodies, and also as to their motions, so long as the general principle of the constitutional motion of the whole is preserved. It is possessed of differentiative attributes, just as the other analogous systems, simple molecules, atoms, and primitive atoms, are possessed of differentiating qualities, which, whilst so differentiating them, yet afford evidence of their genetic relationship. There are no general laws that can be applied to any stage of the sequence from the gyron to the biogen, that are not similarly applicable at all other stages. A force-type that will produce an effect on the gyron, will produce a similar relative effect on a biogen, and if the higher co-type is evolved, the

results of its interaction on the higher organism will be proportionate.*

The biogen is then a system which is subject to the effects of heat, light, gravity, etc., just as are all other systems, and it is differentiated from all others only in the specific attributes, which are the mechanical effects of its constitution.

Between the radium and any other atom there is no obvious difference in tectonic principle. To sufficiently explain their relative durability it is only necessary to conceive the survival of the type which is best fitted for existence under any given conditions. If external conditions are allowed to assume such importance and it is hard to see how this can be avoided, then, and only then, it becomes possible to extend the principle of atomic constitution to the living molecule. Modern views of life seem to require this adaptability, which thus becomes as important

* Just as the internal motion of an atomic or any other system must cease in a definite time unless energy is supplied in the proper form, so must that of the biogen. Like all other systems, it must continuously receive and give out energy. An entire absence or excess of this energy will terminate its existence, just as suitable conditions will tend towards progressive development. Whatever agent in the first instance determined its internal arrangements, external conditions are now responsible for their continuance. Where these conditions allow of complex aggregation, any major effects produced must be the sum of the effects produced in the component biogens, whether the general tendency is towards development or otherwise.

as any other atomic attribute, and no atomic model, electrical or otherwise, which does not allow of this adaptability can, in that case, be considered as sufficiently fundamental.

CHAPTER IX.

RECAPITULATION.

Evolution, complexity, devolution (not dissociation) are the stages in the cycle through which all matter must go. One cycle is but a day in its full history and marks but an infinitesimal step from the infinitudes of space towards the centre of the Universe.

CHAPTER IX.

RECAPITULATION.

P. 64. We have now traversed all the fields in which we are likely to gain any information as to the true nature of electricity.

To obtain a clear view of its place in the universe it was absolutely necessary to go as far as we have gone. It may perhaps be thought that it would have been advantageous to have gone still further; that in every branch of science which has been touched upon further elaboration would have added weight to the general argument.

It is, however, in its beginning that each branch lacks definition, and it is here that the most work is required. Each science is in itself a consecutive detail of facts, each one of which may be said to hinge on the one that goes before it; so that whatever construction we put on the first or most elementary, may be said to influence all the others. If then we have a clear or hazy idea about the meaning of the first, it will be the same with all the others.

The relation of one electrical fact to another is as a rule perfectly clear; but when we come to examine into the relations of either, to heat, light, gravity, or

any other outside fact, difficulty is at once experienced. From the standard works on any of these subjects we can find out, for instance, all about electricity, except what electricity really is; all about life or gravity except what they really are, and relations of one to another.

To add new facts to any science involves the expenditure of much time and thought, and usually also money; yet many are in the field and are striving ceaselessly in this direction. But is it a less worthy object to strive for, the alignment of the facts which we already have? Perhaps it may be thought that these are still too few to allow of any co-ordination that is within the bounds of reason. But this is a matter of personal opinion, and each one must decide the question for himself.

In these pages a co-ordination has been attempted, because without it it was utterly impossible to cast any new light on the principal subject. Whether the conclusions which have been arrived at, are right or wrong, at least they are definite and consistent, one with another. These are just the qualities that appear to be lacking in many of the electrical explanations of effects that really belong to other domains. When the methods of reasoning that may be considered as admissible, when applied to purely electrical effects, are applied to others that lie entirely outside of that science, their weakness becomes at once apparent. The impression is at once produced that something is lacking, both definition and consistency are noticeable in their

absence ; and one is struck by the want of conviction that evidently exists even in the mind of him who advances the argument. Perhaps it will not be amiss to develop this point more, because it illustrates the contention which it has been the object of this work to sustain, which is simply, that something more than the usually accepted electrical idea is needed if we would aim at solving the many problems which still exist around us.

As an example we may take any case where electrical ideas are taken outside the domain to which they legitimately belong. Let us choose "Chemical Action" as an illustration. For many years it has been suspected, and since the advent of the electron it may be said to be a very generally accepted view, that the words "Electrical Affinity" may take the place of the old expression "Chemical Affinity." Let us look into this substitution, and in doing so, use the very latest ideas on the subject that have been given expression to by some of the most eminent scientists of the day.

To have any chemical action we must have an atom, and to reduce the whole matter to an electrical basis it must be an electrical atom. We must then define the electrical atom, and to do this must first state the postulates required. These are simply what any text book on electricity will tell us, namely :—

- (1) Positive electricity.
- (2) Negative electricity.
- (3) Any body which has acquired an excess of positive or negative electricity will be

positively or negatively charged, and if there is exactly the same amount of positive as there is of negative electricity the body will be neutral.

- (4) A body which is positively charged will attract any other body which is negatively charged, but will repel any body that carries a similar charge; and if both bodies are neutral, there will be no action between them.

This seems to be a perfectly fair and lucid statement of the fundamental facts of electrical science.

The developments of recent years enable us, however, to go a little further than this. We can say that the negative charge consists of a number of small charges or electrons, any one of which may be defined as a unit negative charge. Our negatively charged body then carries a certain number of unit negative charges. We cannot say the same of the positively charged body, because the positive unit charge has never been proved to exist. However it is necessary, so we must assume that it does exist, and in any form which for the moment we may require. In the case of the electrical atom we require a uniform sphere of positive electricity. Now we are in a position to define the electrical atom.

The electrical atom is simply a sphere of positive electricity which holds in place, by reason of its attractive power, any where from 1000 electrons in the hydrogen atom to 240,000 in the uranium atom. These electrons are generally supposed to be arranged

in rings, and since they have to account for the generation of light in all its phases, they must be supposed to revolve about the centre of the positive sphere at the rate of several billions of revolutions per second.

We have in this statement a perfectly clear definition of the elemental atom; expressed it is true, in terms of several entirely unknown quantities, but still clear enough for our purpose. Let us now call this an X atom, which may mean a copper or a sulphur or any other kind of atom that we please, and let us further suppose that we have several of them.

Now from what we already know of electricity we must consider this atom as thus constituted, either as having as a whole a neutral charge, a positive charge, or a negative charge. In considering which it is going to be, we must remember that the positive sphere has first of all to balance the negative charges of the other bodies and also their inertia, which on account of their velocity may be very great. So that probably it will be necessary to suppose that the atom as a whole will be positively charged. However this does not matter, let it be the reverse, suppose it to be negatively charged.

Now we have a perfectly clear conception of our X atom. It is a system composed of a positive sphere of electricity and several thousands of unit negative charges, the system as a whole being negatively charged.

Suppose that we now want to build up a simple molecule, say X_2 , to do which it is necessary to find

an exactly similar atom to the X atom just defined. This second atom is also a positive sphere with its attendant negative charges having as a whole a negative charge, and we want it to combine with or attach itself to the other. It at once refuses to do so, obeying the well-known laws of electrical science. But if we insist on having the X_2 molecule, then we must suppose that there are two kinds of atoms; one a positive sphere having a negative charge and the other a positive sphere having a positive charge. Or we may suppose that just as soon as the two positive spheres are brought close together all the negative charges in one body are attracted towards the contiguous surface of that body by the action of the other sphere; and that they in their turn repel the negative charges in the other sphere to the further side. But to do this we must destroy off-hand all the motion of the negative electrons, and we must cause all these strongly repellant bodies to congregate together in close quarters; and this by the action of an equal number of mutually repellant bodies, situated at a relatively vast distance from their centre of mass.

Suppose, however, that none of these explanations are acceptable. Let the X atom be entirely neutral, that is to say, that the positive sphere exactly balances the sum of the negative charges of all the electrons.

Now let us have an exactly similar atom at a short distance away. Since a body that is electrically neutral cannot possibly have any electrical attraction or repulsion for any other neutral body, there can be

no electrical action between them ; and therefore we must conclude, that it is impossible for two X atoms to attract one another. If, however, we take one electron away from one atom and give it to the other, then at once we have different charges and the atoms are attracted. How any one electron can be taken away and transported over the intervening space is hard to imagine. To cause this effect we must suppose that the pull of the positive sphere increases with the distance ; that is to say, that the sphere which is at a distance has a greater attraction for the electron than the exactly similar sphere in which it is first placed. Also in this case, we have the inference that whether the X atom has m or $m-n$ electrons within it, is immaterial. Also, by a continuous process of substitution, under special conditions, we might cause n to become equal to m , and hence we might have an atom consisting of a positive sphere alone.*

* In treating this case in his very important work "The Corpuscular Theory of Matter," Professor J. J. Thompson says :—"We arrive at the conclusion that when two atoms of the same kind come so near together as to exert appreciable forces on each other, one of them may become positively, the other negatively electrified." If both atoms are absolutely identical and absolutely neutral to one another, as it is possible to conceive the atoms of any one element to be, then it seems to add a new mystery to electrical conceptions to say that they are capable of exerting such an influence upon one another, that the characteristic features of both are changed. That two electrically neutral bodies under the circumstances stated, no matter what their size, possess within themselves an in-

There seems to be no other stand that can be taken in procuring for the electrical atom the necessary power of attracting atoms of the same element, and yet this is the strongest "Affinity" that some atoms may be deemed to possess. As regards dissimilar atoms the case is different. They may be deemed to possess whatever constitution is necessary to suit the case, but even then present great difficulties.

We thus see that even in its first and most elementary application the electrical atom seems to fall short of requirements, and when on top of this we ask it to do its share in producing gravity, mass cohesion, and the other static forces for which it must be held responsible, the difficulty does not seem to decrease.

To make the electrical atom fulfil requirements, we have to create new postulates, or have to modify those that are already accepted. But these are based on facts about which there can be no doubt. We know positively that matter will attract matter under

herent property by means of which one may become positively and the other negatively electrified, is a view that seems most difficult to grasp and to fit in with other accepted electrical theories. To bring about the change of sign in the two atoms one of them must lose a corpuscle, which requires that work must be done. Since neither possesses a capacity for doing work that is not also possessed by the other, and since, notwithstanding this equality, the transference of the necessary corpuscle is possible, then we seem to have an entirely new electrical possibility presented to us.

certain conditions, and we know positively what these conditions are when we define the attraction as electrical. Without these conditions and this attraction there is no such thing as electricity; with them, we have a basis for the electrical conception. When, therefore, we compel the electrical atom to perform certain acts, which require that its attributes are non-conformable with the postulates, we attack the validity of these and therefore the conception that is based upon them.

Also since the postulates may be considered as representing nothing but a concise statement of observed facts, we may say that the statement "Chemical Affinity is Electrical Affinity" is absolutely at variance with the facts. This applies so long as the atom is considered to be a positive sphere enclosing a number of negative electrons.

We therefore seem to be tied up to the necessity of evolving some better idea, wherein the conception of positive and negative electricity is more consistently applied, or else of reforming our ideas as to the postulates.

The electrical atom is however the most ingenious and plausible conception that has yet been evolved, or perhaps that it is even possible to evolve; and since advance in this direction is not to be expected, it seems that we must attack the problem at its beginning and not at its end, and this is exactly what has been attempted in these pages.

But now let us suppose that the electrical atom does explain chemical attraction, intra-atomic at-

traction and mass cohesion, and also the various phases of heat and light vibrations; we still require other forces to build up the universe as we know it, and these still remain unexplained. We require in this case—

Positive Electricity,
Negative Electricity.

An unexplained Attractive influence between
them.

Ether.

Gravity.

Life.

There seems at present no possibility of further consolidation in these premises, they remain, as between themselves isolated facts, having no relation to one another. We cannot express life in terms of positive electricity, for instance; or gravity, in terms of positive and negative electricity.

Now, in the gyron theory we have arranged the main facts in an homogeneous and inter-related series, wherein the relation of each term to the next is perfectly plain. In doing so we have required as postulates—

Absolute Energy

Ether

One unexplained form of interaction between
them.

And supposing that each of our four principles is at variance with observed facts, in the same way as is the electrical atom; then we require four more, or seven postulates in all.

If we inquire now into the respective merits of the

two theories, we find then that as far as the initial concessions are concerned there is little difference. When, however, the relative value is measured by the facts that they explain, or may be made to explain, the advantage seems to lie with the latter.

Furthermore, the application of the second theory is so simple that it has already extended our knowledge, for the relations shown in Tables IV. and V. were arrived at in no other way.

It cannot be said that these relations are of no value or of no interest. Every chemist who has ever pondered over the meaning of the Octaves of Newlands, the Triads of Dobereiner and the general Periodic Functions of the elements, must recognise that in the relations there shown we have a possible explanation, and an explanation that is in itself not difficult to understand.

Whether the gyron theory, as a whole, is right or wrong; whether its premises and deductions are wrong in their inception and more wrong in their application, the fact will still remain that through it a set of interesting facts has been disclosed.

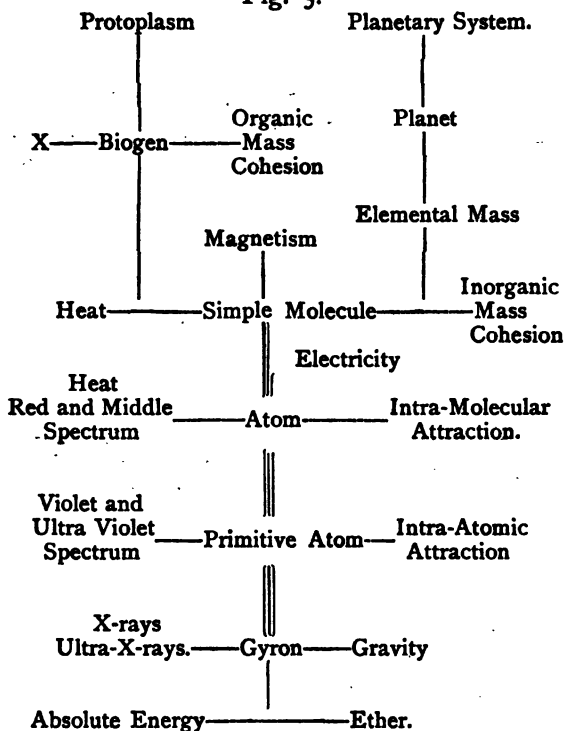
In former pages electrical science has been assigned a certain clear and well defined position in the cosmic scheme, and further consideration seems but to confirm the assignation and to add weight to the definition which has already been offered.

It only remains then to make this position as clear as possible and then our work is done.

The whole range of modern science is like a tree, which under the influence of some great magician, has

developed its branches without having any clearly defined trunk to support them. To more clearly define the trunk is now our object, and this may perhaps best be done by following out the idea of the tree. Figure 5 will enable us to see at a glance the

Fig. 5.



relation of every phase of matter and energy to every other, and of each to the primary something that moves and the something that is moved.

In the above genealogical tree the principal Alpha-forces of each system are placed on the right and the Beta-forces on the left.

This genealogical tree presents to us a bird's-eye-view of the history of that evolution, which has been responsible for the things that we see around us. The points at which the off-shoots, labelled electricity and magnetism, leave the parent stem are definite and clear; and in climbing to this point and measuring the distance to the ground, the task which was set us in the beginning has been accomplished.

But there are other interesting considerations in connection with this tree, which we may briefly discuss before leaving the subject.

P. 65. We have followed the history of this tree from the period of germination to that of full maturity. In the history of every plant and tree, there is a time which follows after that of full maturity; a sad time of failure and decay; a time that merges gradually into the last stage of all, when energy is lost and individuality ceases to exist. A time when the elements that erstwhile formed a magnificent organisation, full of strength and vitality, are scattered to the winds, and thenceforth know each other not.

The inexorable laws of Nature that apply to the most elementary biogen, apply also to the stateliest monarch of the forest.

The allegorical tree of evolution, and perhaps the universe itself, must conform to the ever recurrent cycle—birth, growth, and death.

We have sufficient evidence, geological and physical, to show conclusively that this planet has passed the stage of full maturity, and is entering upon the last and final stage of devolution.

The work of Sir Norman Lockyer, already referred to, leaves but little room for doubt, that while many stars are in the evolutionary stage, a great many more are just as surely in the devolutionary stage. That is to say, that whilst in the former, decrease in temperature makes many complex atomic forms possible; in the latter, the temperature is increasing, and the complex atomic forms are disappearing. Apart from the strictly logical evidence that there is for this view, the process is so entirely reasonable and conformable with everything else we see around us, that we naturally hesitate to raise any objection whatever to the possibility. We may accept it, but in so doing we render ourselves liable to produce an explanation for it.

We may well enquire how it is possible to fit in this demonstrated fact with all the others that we have considered. It is easy to see that when all the particles that go to make up a star are in a violent state of motion, as they must be in first coming together; that the mass thus formed will emit all the conceivable forms of ether vibration that are classed as heat and light. But allowing that such a body goes through its evolutionary stage, and attains to that state of stability which is illustrated in this earth, for instance: how are we going to explain the subsequent process?

This earth cannot suddenly become heated to say 25,000° as in the case of Lockyer's Achernian group of stars, in which group the more complex elements have not yet appeared. The star beta-Crux is in about the same stage as the other, but has arrived at it by an entirely different process. The temperature of Achernar is decreasing and that of beta-Crux is increasing. There must be a point mid-way between the stages of these two stars, at which beta-Crux arrived long ago, and towards which Achernar is approaching. At this point the evolution of complex forms ceases and devolution begins, and it is therefore similar to that which the earth attained long ages ago. This devolution must be caused not by an excess of energy but by a deficiency. Now, if the complex atoms and groups that once existed in beta-Crux had been made up of positive spheres of electricity, with their attendant electrons, it is difficult to see how decreased energy could account for the subsequent process. The more completely the energy of motion of the electrons had been lost, the more completely they would have been attracted towards the positive sphere, and the less likely would it be for dissociation of any kind to have taken place under the circumstances.

In this case the difference between devolution and dissociation becomes very forcibly illustrated. Dissociation may take place in the case of a complex group which is suddenly subjected to an increase of internal energy, which is greater than its constitution can withstand. In this case it is possible to imagine

the disruption of the electrical atom. Disruption may however take place in another way, and that is purely by loss of energy, as in the case of the radium atom. This is then a simple devolutionary process, and is absolutely distinct from the other. If then devolution may be considered as due to decrease of internal energy or motion in a system ; that motion itself must be the cause of the force which preserves the integrity of the system. This force must then be subject to some such law as is contained in Principle II.

Dissociation then, pure and simple, such as is illustrated in the sun, is of relative unimportance ; whilst devolutionary disruption, as in the radium atom, is just as vital a phase in the general devolution of a system as gravitational attraction is in its evolution. Both of the latter are spontaneous and inherent properties of matter, whilst dissociation is not, for it requires the application of external force. We may then suppose that long ages ago, beta-Crusis was in the same stage as our planetary system is to-day. Devolution proceeded and it went on till the energy of the component atomic systems, in first the satellites, had been used up. Every complex molecule of atoms and primitive atoms was resolved into more simple forms. They had on account of their loss of motion practically ceased to develop any Gamma-force and disruption consequently took place. This process was continued until each of the satellites, in turn, was unable to retain its place in the system, and hence gravitated towards the central sun. In falling

towards the sun, new energy was acquired by each individual primitive system that remained, and this energy was transmitted gradually to the whole mass of the sun. As each gaseous satellite fell into the sun new energy was added, and the temperature rose and kept on rising, as the vast amount of energy acquired by the falling satellites was absorbed. But this process must sooner or later also have an end. The temperature will fall, evolutionary complexity will again begin, and again devolution until there is no energy left, even in the central body. It will then be an inert and invisible body, having no internal motion rapid and regular enough to generate a light wave, and it will be only feebly cohesive by reason of the Alpha-force of its constituent gyrons.

Even in this state, however, this body will have a long history in front of it, which it is not necessary to go into here.

In its last devolutionary stage it will be representative of that, towards which the whole universe is tending, unless there is a regenerative force at work, of which we know nothing.

We find such a regenerative force at work in the only complete cycle, that is, begun and completed in such a time that we can observe it. The complete cycle of the biogen, and of most of the complex molecules which are its descendants, includes the process of regeneration. If it were otherwise, the entire active life on the earth would cease within the hour.

The constitutional motion of the gyron itself may

cease, and in the place that knew it, there may remain nothing but the quiescent ether without a ripple but that which comes from some perhaps far distant system, still in the zenith of its youthful energy. If it is conceivable that even the gyron after its untold ages of useful work may pass away, so may it, like the biogen, have set in motion, during its life, influences that may be the cause of regeneration. Away far out in space, beyond the furthest star, the early history of the gyron may be again in progress. As the universe itself draws into some great centre and each unit ceases to exist, outside, in illimitable space, some new-born product of regeneration may take its place and thus complete the cycle.

The internal constitutional motion of the gyron is after all of the utmost simplicity. Rotational motion in all possible directions might be caused by the proper impulse coming from only three different directions, the only requirement being that these directions shall be at right angles to one another.

In the beginning, the possibility existed and was effective, and the Great Cause of that possibility has not ceased to exist.

Finally then, every phase of matter and energy is reducible, in its last analysis, to a simple interaction of a prime mover and a something that is moved. All subsequent processes or phases carry the impress of this first interaction, and are thus reducible in all cases to the effect produced by the mover upon the moved. We have then in every complete process, first, distinctive motion; second, a mechanism for

transmitting the energy of that motion to external systems; and third, the receptive system.

Every phase of organisation which is the result of acquired motion, then becomes subject to a cyclical process, wherein the initial energy produces an evolutionary complex organisation; but as the energy is dissipated the organisation is subjected to devolution and the energy set free may in all cases perhaps be productive of similar organisation elsewhere. Every complete process in the universe then becomes subject to definite laws, which deal with its distinctive progressive phases, and these phases are—The acquisition of energy in distinctive form; evolutionary complexity due to individual energy; the devolution of this complexity owing to the dissipation of energy; and finally the termination of existence, owing to the complete dissipation of the energy.

The human mind is so differently constituted that whereas a fundamental theory may appear to be a necessity to some, to others, not less surely, it will appear there verse. The reality, however, must be fundamental and in attempting to approach it, whether by theory or experiment, this consideration cannot be lost sight of.

It may be said against a purely theoretical work such as this, that it is entirely wrong in principle, and that it is like building a house of sand; that facts and not theory are the only building material that should be used in science. This might be admitted, but to be fair, the application of the argument must

then be extended to all other theoretical conceptions, and this would embrace the greater part of human knowledge. The interpretation of any one fact, whether it be great or small, is merely a matter of individual opinion; and thus we find the greatest scientists of this and all other ages divided in their opinions as to the true meaning of many of Nature's simplest works. Even if there is practical unanimity amongst the deepest thinkers of the age, their theory, for it can be nothing else, no matter how well the facts sustain it now, may in the future be wondered at for its futility. A theory, no matter by whom advanced, must then be considered as tentative, and its value as relative to the number of facts that it temporarily explains.

There is, however, another side to the question. A theory must not only interpret the discoveries of the past, but it may and should open up new fields for future thought and work. The development of the gyron theory has disclosed at least one such field—Intra-Atomic Chemistry.

It is not, of course, claimed that the general idea is new. Intra-atomic chemistry has been hinted at by many authors. It is, however, claimed that a workable basis is here presented for the first time. It is, however, only a basis, and it will entail a vast amount of work, both mathematical and experimental, to reduce the possibilities that are evident, to the certainties that are beyond dispute.

The tables and general conclusions relating to this new science, which have been given in former

pages, were elaborated about December, 1906 ; and they have already received a measure of confirmation in the work of Sir William Ramsay, whose work may be considered as amongst the most important developments of the age. His experiments in breaking up the atom, and thus proving that it is in effect a simple molecule, made up of more primitive atoms, may or may not prove the applicability of our theory at this point. His results are however remarkably akin to those that it would suggest, and they thus add to its general value.

A little confirmation, a little disproof, what does it matter ? If either allows of a closer approach to the truth, then are they welcome.

To get one step, however small, nearer to the greatest of all great physical truths—the Eternal Principle of the Universe—has been our aim ; and it lies in the hands of Time to sustain, or to completely discredit the methods used in its attainment.

APPENDIX

Up to the present point practically no mention has been made of Spectrum Analysis and its bearing on the general theory which is here advanced. It has in fact very little to do with the subject which it has been more particularly the object of this work to discuss. To make the contention as clear as possible, it has been necessary to go into some subjects which are apparently unrelated to electricity. A definition of this force is primarily what was required, but to make this definition carry any weight, it was necessary also to define the place which Electricity may be supposed to occupy amongst other natural phenomena.

Because it may strengthen the general contention, and therefore the definition, which has been given, and also because it may be of interest to some of the readers of this work, we may here briefly discuss some of the recent wonderful developments in spectrum analysis, and their effect on the conclusions which have been arrived at.

Perhaps the work which of all others contains the most advanced and clearly expressed views on the evolution of the elements, as developed by spectro-

scopic work, is "Inorganic Evolution," by Sir Norman Lockyer, and the reader who is anxious to acquire more knowledge on the subject cannot do better than refer to it. He expresses some opinions which, one cannot help thinking, might have been further developed with advantage.

On page 166 he says, for instance, "In all these changes we seem to be in the presence of a series of complications the possibility of which depends upon a reduction of temperature. *There may have been roughly a series of doublings.*"*—

In this short sentence we have an opinion which has been arrived at after an immense amount of careful reasoning and research, and who can at present say that in it we have not the veritable key to the most imposing evolutionary processes.

It is now inconceivable that the atom of any element should have come into existence ready-made, and once dissociated, that its parts should have any other than a general relation to one another. That is to say that when subjected to a very high temperature, the parts of any atom absolutely cease to belong to that atom. They are, in fact, as well fitted by their constitution to form a part of any other atom as the one to which they originally belonged. They become free bodies, unrestrained by any communal laws. If circumstances should eventually allow them to reassemble, there does not appear to be any good reason why the binary relation

* The italics are mine.

or actual doubling, should not be of just as much importance between the parts of an atom, as between bodies as large as the sun. More than 10,000 double stars have been discovered,* which illustrates the importance of the binary relation at the upper end of the evolutionary process, and adds reasonableness to the assumption of the same relation at the beginning of the evolution. The consequences of this assumption have already been given in Chapters I. and II. The Elements Hydrogen, Anonium, Helium, Element (8), Oxygen and Sulphur have been indicated as probably true binaries, and these are thus differentiated from all other atoms.

The element Astertium probably corresponds to that which, for convenience, has been named Anonium in former pages. The spectrum of Astertium is very similar to that of Helium, and the spectrum of the Radium Emanation (Anonium on this theory) also closely resembles that of the Helium family.†

Of the next step in the binary progression, the element whose atomic weight is (8), we know nothing. All we can say is, that the series in the Beryllium group works out much closer using (8), than with any other number. I think it has been shown, that it is not unreasonable to suppose, that there are many more groups than are used in Mendeleef's classification; so that there may quite well be an (8) and a (9) group.

* Popular Astronomy. Flammarion and Gore.

† Radioactive Transformations. Rutherford.

The suggestion thrown out by Lockyer, which is quoted above, will explain a lot, but it is doubtful whether it will explain everything. Whatever forces may be considered as liable to cause doubling, must also be reckoned with when two dissimilar bodies are in proximity. Hence the necessity of two or more simultaneous progressions. If we allow these different progressions, and the idea that whatever ether vibrations are caused by their components, are due to their rhythmical circular movements in definite minute orbits, and not to plain to-and-fro vibrations, we seem at once to be on firmer ground. The old idea that the to-and-fro vibrations of any one molecule, should be held accountable for such beautiful rhythm as is indicated in the 3 series of say Helium, is a proposition which seems to be most difficult to sustain.

Lockyer says, referring to this point—

“Observations of the Sodium phenomena alone are simply and sufficiently explained by supposing that we have three different masses vibrating.”* That is to say, that one mass causes each series, which in the element mentioned consists of at least seven lines each. How one mass vibrating with the restrictions that must be held to exist, even at high temperatures, if there is atomic individuality, can produce seven such regular lines, he explains by supposing further subdivision. If we hold that each mass is subdivided into at least seven smaller masses,

* Inorganic Evolution, p. 178.

we seem to get a definite basis to work upon. But it seems to be possible to go even further than this if we specify the nature of the vibrational motion. In this case it seems possible to further simplify the conception by saying that *one mass* revolving round some centre and consisting of seven different centres within that mass is all that is required. The proposition depends on the following considerations. Any small body following a circular or elliptical orbit will cause an ether vibration, whose characteristics will, firstly, depend on the orbital range and velocity and, secondly, on the translation of the orbit.

Fig. 6 will make the preposition clear.

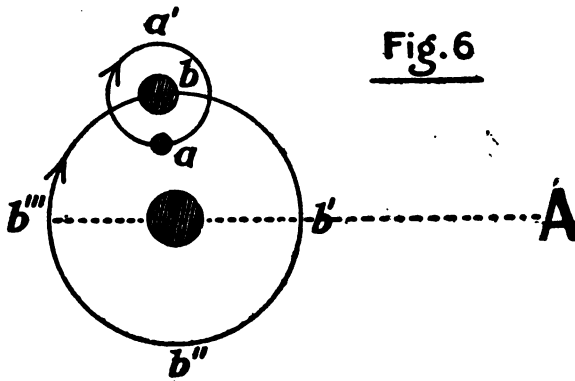


Fig. 6

A particle a is revolving in the direction indicated, in an orbit $a a'$, about a centre b , at a velocity sufficient to cause a light wave. The centre b is moving as indicated in the orbit $b b' b'' b'''$ of atomic

dimensions at a velocity somewhat less but related to that of a . Now supposing that there is an observer at A, feet or miles away, the simple body a will cause three different vibrations to be communicated to A according as the centre b is at b , b'' or b' . If a is not a simple body, but is made up of a number of smaller masses revolving rhythmically within its confines, and is consequently continuously causing the emission of a regular series of waves, then whatever spacial characteristics the series of lines may possess when at the points b' and b'' , will be approximately preserved when at b and b'' , with the difference however, that the series as a whole will be shifted in the one case towards the violet and in the other case towards the red. Furthermore, as the differential motion is added in the one case and subtracted in the other, the shift will not be equal in both cases, and will in both cases, effect the lower frequencies in the series to a greater extent than the higher. On this supposition the first subordinate series would become the principal and the other two would be derived from it.

In the solar spectrum a shift in the spectral lines of 0.075 Å U is produced by a difference of velocity of 4 kilometers per second.* Here the translative motion is very small as compared with the orbital motion of the light emitting particle, but there does not seem to be any experimental data that will enable us, at present, to state definitely what the

* Watts' Spectrum Analysis, p. 184.

[Face Page 251.]

Fig. 7.



1



2



3

1. NITROGEN.
2. MAGNESIUM.
3. CARBON.

*From "Inorganic Evolution," by Sir Norman Lockyer,
by kind permission of Macmillan & Co., Ltd.*

shift would be when the translative motion is only a little less than the orbital. If the shift increases regularly as the translative motion approaches the other in magnitude, then we have a simple explanation of the occurrence of three regular series in the spectrum of what are, on this theory, the most simply constituted of all the elements.

Binary structure should be of all others the most suitable for producing in this way three simple series, whilst in the planetary structure we could only expect to find these three series clearly defined, where a great difference exists between the central body and the others.

It is also clear that on this view a binary, such as Hydrogen, might emit three or more different strong related lines, which might appear to belong to one series, but which, on being subjected to more intense heat, might be definitely located as members of three different series. How the increase of temperature would cause the new lines has already been discussed.

In the case of large and complex atoms, series would still exist, but would be most difficult to untangle. As a general rule it appears to be the case that the more symmetrical and simple is the structure of the atom, the more beautifully regular are the results produced by the spectroscope. As examples, consider the flutings produced by Carbon (Formula, $8+4$), Nitrogen (Formula, $8+4+2$), and Magnesium (Formula $16+8$). See Fig. 7.

We may now pass on to a consideration of what

the spectroscope tells us of the sequence of atomic evolution. According to the views of the modern chemist this is a most difficult subject. The elements do not appear in the stars in the order which the accepted theories would indicate as being correct. It is certainly difficult to assign a reason for the discrepancies, and just as certain that they exist. Possibly the real reason of our inability to reconcile theory with facts, may lie in the present incompleteness of our knowledge, and the consequent impossibility of fully grasping the "majestic simplicity"—as Lockyer terms it—of the fundamental laws that govern the evolutionary process.

Following out the simplest possible conception—that of doubling—a scheme has been outlined in Chaps. I. and II. in which we have as a basis to work upon five steps in the principal progression, namely, Hydrogen, Astertium, Helium, Element (8) and Oxygen. These elements have been termed epochs, because they must have formed well marked stages in the evolution. It has been supposed that as each epoch was arrived at, its first business was to enter into combination with pre-existing types, and after all immediate requirements in this direction had been satisfied, it could then itself become evident as an element.

We should thus have in the stars of the Argonian type,* the earliest stages of Hydrogen (1), Astertium (2), Helium (4), Element (8), and first stages of

* Inorganic Evolution, p. 70.

Magnesium ($16+8$), Neon ($16+4$) and other types which are unknown.

Following at once upon these, in the Alnitamian type, we should have the above elements and the first definite developments therefrom, representing the types intermediate between each pair of the first. These would be represented by the atomic weights

3 . 6 . 12 . 24

and as secondary developments from these, Proto-Calcium ($2(16)+8$), Silicium ($16+12$), unknown ($16+6$), Fluorine ($16+3$) and Oxygen. At the same time we should have minor developments preparing for Manganese, Iron, Cobalt and Nickel, and probably also Titanium, Vanadium and Chromium, which elements do not seem to fit into their present position at the other end of the Table. Fluorine is the first of the Halogens that should appear, but Chlorine is mentioned as a possibility by Sir Norman Lockyer in the Achernian stars. The mere possibility of the occurrence of any of this group at such an early stage seems to indicate a possibility that the position assigned to it in Table VIII. may not be far wrong.

This subject is so important that perhaps it will not be amiss to still further accentuate the simplicity of this, the primary step in the evolution, or I should say rather, the primary step which the means at our disposal allow us to perceive.

First, I will again quote from the Inorganic Evolution, p. 177.

TABLE IX.
SHOWING EVOLUTION OF MAGNESIUM AND CALCIUM.

	H. (1)	Ast. (2)	He. (4)	X (8)	(O. 16)
Primary Argonian	—	—	16+4 Ne=20	16+8 Mg=24	
Secondary Argonian	—	—			
Primary Alnitamian	X (3)	X (6)		C (12)	Mg (24)
Secondary Alnitamian	16+3 F=19	16+6 X=22		(16+12) Si=28	(16+24) Ca=40
Tertiary Alnitamian	3+1 Fe. first stage	8+6 N=14			O=16

"The magnesium, and I will now add calcium, which the chemist studies at relatively low temperatures, have atomic weights of 24 and 40 respectively, and the stellar evidence would be in harmony with the periodic law if magnesium (24) made its appearance after sodium (23), and calcium (40) after chlorine (39), and generally each substance should make its appearance after all other substances of lower atomic weight than itself."

This expresses the difficulty clearly and concisely.

Table IX. shows the derivation of magnesium and calcium according to my view.

The sequence shown in this table is worked out in accordance with the theory which I have found necessary to elaborate in this work, it is in almost exact accordance with the stellar evidence and also with, and explains the significance of, the Periodic Law of Newlands.

Periodicity is unquestionable, and the reason of it obvious when we consider Tables IV. and V., but to fully explain the properties of the elements it is necessary to grant even more groups than are shown in Table VIII. The periodic law, if bound down to the period (8), *does not hold*. Mendeleef in his effort to make the period (8) applicable was forced to crowd three groups into one and leave Hydrogen and the Helium group entirely outside its possible range. The period (16) will find a place for all the obvious groups and also the subgroups which the spectroscopy and modern chemistry have proved to exist.

I submit then that the possibilities shown in Table IX. afford a valid reason for reconsidering the general conclusion expressed in the last quotation from the "Inorganic Evolution."

May we not write?—

The fact that magnesium (24) and calcium (40) do not make their appearance after all other substances of lower atomic weight, brings the Stellar evidence into harmony with the periodic law, provided that this law is applied in accordance with modern knowledge.

THE END.

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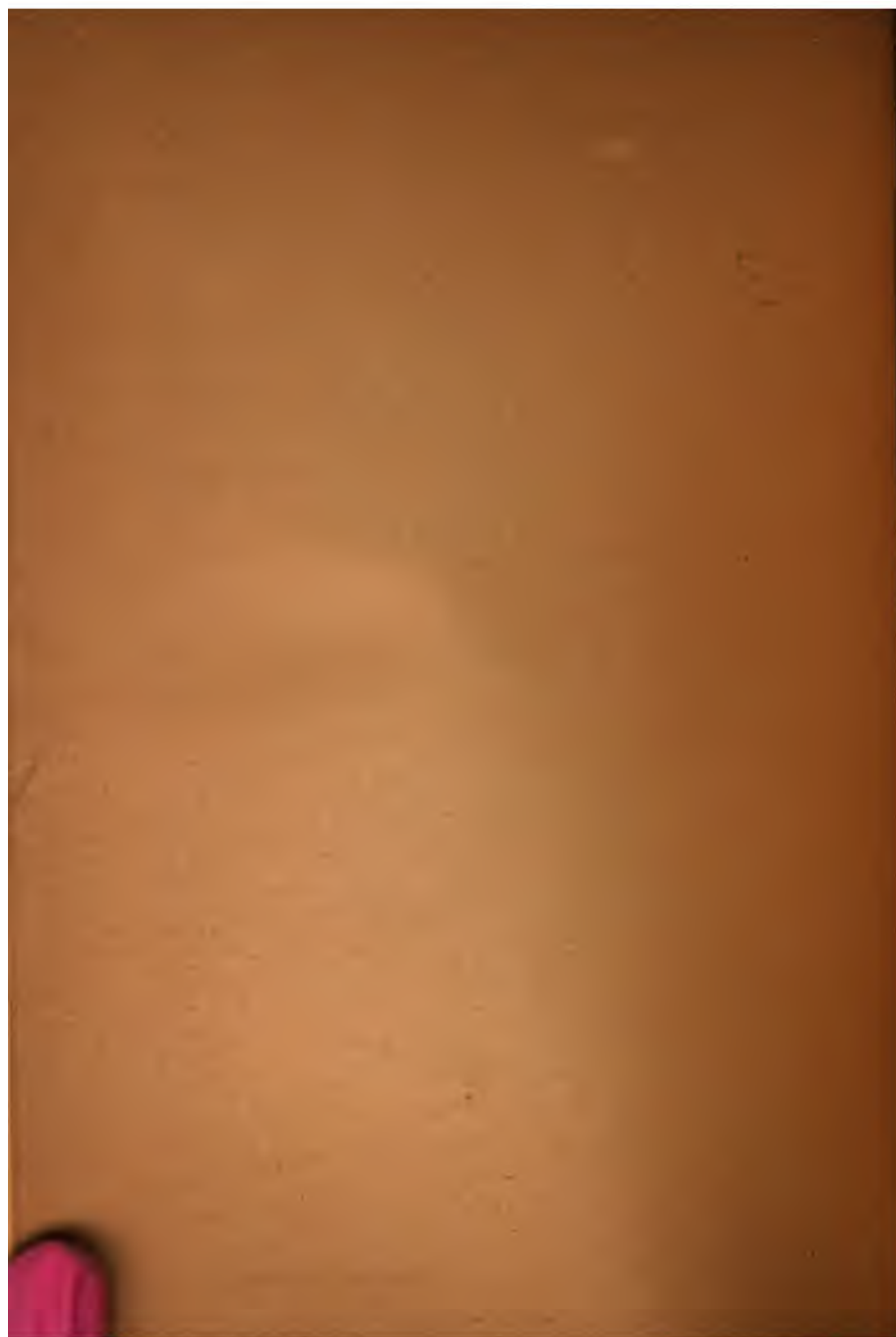
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